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WILLIAM FAIRBAIRN, ESQ. C.E.

LL.D. F.R.S. &c.

President of the British Association for the Advancement of Science, 1861

THE

YEAR-BOOK OF FACTS

IN

Science and Art:

1861

EXHIBITING

THE MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS OF THE PAST YEAR;

IN MECHANICS AND THE USEFUL ARTS; NATURAL PHILOSOPHY; ELECTRICITY; CHEMISTRY; ZOOLOGY AND BOTANY; GEOLOGY AND MINERALOGY; METEOROLOGY AND ASTRONOMY.

BY JOHN TIMBS, F.S.A.

AUTHOR OF "CURIOSITIES OF SCIENCE," "THINGS NOT GENERALLY KNOWN," ETC.

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Building for the International Exhibition, 1862.—(See page 13.)

LONDON:

LOCKWOOD AND CO., 7, STATIONERS' HALL COURT.

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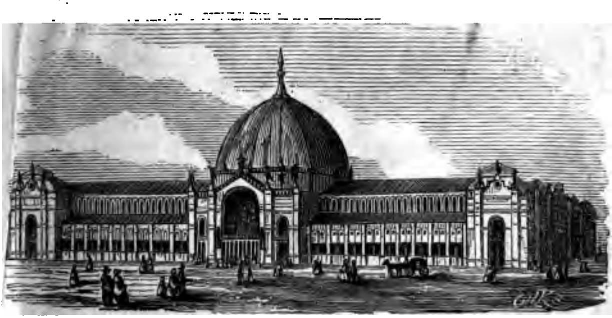

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COVENT GARDEN.

WILLIAM FAIRBAIRN, C.E., F.R.S., LL.D.

(*With a Portrait.*)

THE characterization of the Ages of the World by association with its Metals was a favourite myth of the Greek and Roman poets. They had their Age of Iron, deemed to have commenced long before the day of Hesiod, who lived, probably, at least twenty-six hundred years ago; but this was merely a general name for the existing order of things, as distinguished from some imaginary previous state. This poetic painting, however, consisted but in slight varieties of shade, and had little or nothing to do with the history of the actual world. Tubal Cain was, ages before the time of Moses, "an instructor of every artificer in brass and *iron*." The art of smelting iron was known in England during the time of the Roman occupation; in the Middle Ages, and down even to a late date, the forges of Kent and Sussex were all aglow with smelting and hammering the iron of their soil; then came the smelting with coal, and the blast-furnace; the mighty power of the steam-engine superseded the descendants of Tubal Cain in working the metal, and thus the *Iron Age* became applied to the stupendous realities of our own time instead of being borrowed from the poetic myth of the antique world.

Among the thinkers and workers in our Iron Age, William Fairbairn is entitled to high rank,—presenting a combination of the theoretical and practical man, such as is rarely to be met with. He was born at Kelso, on the north margin of the Tweed, in 1789, and was brought up as a mechanic at Newcastle-upon-Tyne. In 1817, he commenced business in Manchester, in partnership with Mr. Lillie, and the firm soon rose into the very foremost position in the trade of that city; and when this partnership was dissolved, Mr. Fairbairn continued the business.

About the year 1830 or 1831, he commenced various trials as to the forms of vessels, and employed a small iron vessel for that purpose. The success of his experiment emboldened him to proceed, and by 1836, he ventured on the construction of iron vessels of considerable tonnage.

Mr. Fairbairn was one of the earliest members of the British Association for the Advancement of Science, to whose Proceedings he has contributed some valuable papers on engineering, his great subject being "Iron." In 1837, he read to the Association an elaborate Report on the Comparative Strength and other Properties of Cast-iron, manufactured by the Hot and Cold Blast respectively; in which were employed irons of fifty sorts.*

In 1840, Mr. Fairbairn read to the Association a paper on Iron Shipbuilding, wherein he went into the extent to which the strength of iron plates was affected by the rivet-holes; and the general deduc-

* See *Arcana of Science and Art*, 1838, pp. 93-97. Also, Year-Book of Facts, 1840, *p. 85.*

tion made from his experiment was, that there was a loss equal to about 32 per cent. As to the comparative strength and safety of iron boats, it seemed to be a general opinion that they were preferable to wood in most respects; and Mr. Fairbairn then predicted that iron would entirely supersede wood in the course of four or five years.*

In 1847, Mr Fairbairn patented his method for the Construction of Hollow Wrought-Iron Beams: the mode is to form the beams of stout plate-iron, riveted at the points to strong T-iron, and at the angles to L-iron, to give additional strength, and prevent buckling and deflections as much as possible. A transverse section represents three chambers, the two square ones at top being together rather wider than the upright one, and all bolted together in the most substantial manner. In his specification for these hollow beams, he describes them under different constructions, suitable for mills, factories, warehouses, dwelling-houses, bridges, &c.†

When Mr. Robert Stephenson had resolved upon the construction of his Tubular Railway Bridge for crossing the Menai Straits, he confided the experiments to be made upon the strength of iron for that purpose to Mr. Fairbairn, who was considered to possess more practical experience of the power and strength of cast-iron than any other individual. With Mr. Fairbairn was associated in these experiments, Mr. Eaton Hodgkinson; and subsequently, Mr. Stephenson added one of his own confidential assistants (Mr. Edwin Clark), who regularly recorded, and reported to Mr. Stephenson the result of every experiment. Mr. Fairbairn was appointed assistant-engineer by the Railway Company, on the 13th of May, 1846: a claim was subsequently made by Mr. Fairbairn to *the idea* of the self-supporting Tubular Bridge; a strong controversy ensued; and all who take interest in the matter will find it fully discussed in Sir F. B. Head's very clever *Highways and Dryways*, and in Mr. Fairbairn's *Truths and Tubes*, to which Mr. Stephenson's caustic champion, Sir F. Head, subsequently replied through a newspaper channel.

Previously to the experiments instituted for this bridge, observes Sir F. Head, "it had been long considered almost a mechanical axiom, that iron possessed a greater power to resist compression than extension," whereas it was discovered by Mr. Fairbairn, that, "after bearing a certain amount of weight, the resisting properties of cast and of wrought-iron are diametrically opposite. Cast-iron can resist per square inch—compression of from 35 to 49 tons; extension of from 3 to 7 tons. Wrought-iron can resist per square inch—compression of from 12 to 13 tons; extension of from 16 to 18 tons." If these experiments had not been instituted, the tubes would have been erroneously constructed stronger at the bottom than at the top, which might have lead to disastrous results. Tubes were constructed of circular, elliptical, and rectangular forms, and, after 40 experiments, their relative strength might be thus expressed in figures —13; 15; 21. The rectangular form being prodigiously stronger

* *Year-Book of Facts*, 1841, p. 70.
† *Mining Journal: Year-Book of Facts*, 1848, p. 57.

than the others, was adopted. The word *tube* has been objected to, as suggesting a round pipe; tubular is more correct, since the whole strength of the bridge resides in the tubular top and bottom. It may be ascertained, by a simple calculation, that a solid bar of iron —could such a thing be made—of the same length, breadth, and depth, as one of the large tubes, would not even bear its own weight! The experiments by which the stability of these Cyclopean bridges was thus secured, called into exercise by Mr. Fairbairn and Mr. Hodgkinson a union of the highest mechanical and mathematical skill, and not merely sufficed for the immediate purpose, but have effected a sure basis for the labours of succeeding engineers. The result was the demonstration that the greatest amount of strength would be obtained by giving to the materials the form of a hollow quadrangular beam or girder, somewhat larger in section in the centre than at the ends, and making the top and bottom, (or the floor and roofs,) instead of being solid, to consist of shallow tubes or cells.* How fertile a principle this has proved need hardly be pointed out: it is to having been constructed on this principle that the *Great Eastern* steamship owes its enormous strength.

Mr. Fairbairn was an active promoter of the Great Exhibition of 1851, as a juror and an exhibitor: among the contributions of his great establishment at Manchester, (W. Fairbairn and Sons,) were a six-horse power steam-engiue; wrought-iron tubular crane; inside cylinder tank locomotive engine; and a model of a tank locomotive engine. The firm also sent their important and original machine for riveting boiler-plates by pressure; and their corn-mill on a cast-iron frame with gearing, showing their improvements in the modes of driving, adjusting, and feeding the millstones. For this machine and mill Messrs. Fairbairn received the Council Medal.

In the same year (1851) Mr. Fairbairn read to the British Association a most important paper, "On the construction of iron vessels exposed to severe strain," including the results of his experiments on the resistance of malleable iron plates, beams, and angle-irons; continued, from time to time, for improving the construction of malleable iron bridges, boilers, and other vessels, such as caisson and sheet-iron pipes, coming into more general use for pump-trees and other articles connected with mining. A variety of plates from Low Moor, Staffordshire, and other parts, were submitted to direct experiment; first, by tearing them asunder in the direction of the fibre; and secondly, across it: the strength proved uniform, probably from the superior manner in which the article is now manufactured. The experiments were completed, by results as to the process of riveting, by which it is now proved, one-third of the strength is lost. In conclusion were shown several important improvements in steam-boilers, by gussets to strengthen the flat ends and retain them in shape.†

The strength of Iron Ships was also ably illustrated by Mr.

* See the papers by Professor Cowper in *Year-Book of Facts*, 1851, pp. 37-39.
† See the paper in *Year-Book of Facts*, 1852, pp. 34-36.

Fairbairn in a paper read by him to the Institute of Naval Architects, in 1860; wherein he proposes a plan for securing the most effective distribution of the material which is to be added to the upper part of the ship :—

Iron vessels are ordinarily constructed with ribs or frames placed from fifteen to eighteen inches apart. They are about two feet deep at the keel and taper to the width of the angle-iron round the bilge on each side. From that point to the top of the deck the angle-iron is in some cases considered of sufficient strength for the reception of the sheathing-plates. On the top side of the ribs a lighter description of angle-iron is riveted, and to this the flooring, whether of wood or iron, is attached. This plan of construction is not objectionable, provided two more longitudinal stringers on each side of the keel are made to run from one end of the ship to the other, and in large ships chain riveted as previously recommended, which will greatly enhance the value of the ship. If this were done so as to give the required midship section necessary for the security of the vessel, it would prove highly advantageous. The *Great Eastern*, which is probably the strongest vessel in proportion to her size ever built, is constructed on this principle, and the designer, the late Mr. Brunel, was too sagacious an engineer to lose sight of the cellular system, developed first in the Britannia Bridge, to neglect its application to the deck as well as the hull of the monster ship.

With smaller vessels, however, this system is not applicable ; but Mr. Fairbairn proposes a modification of it by a new and more scientific distribution of the material, and not any great increase of sectional area, and consequently of weight throughout the combination, so as to have in the hull and deck a maximum area of security, and ensure the vessel against breaking up under the most trying circumstances.

"As respects the quality of the iron used for shipbuilding, the greatest care should be observed," Mr. Fairbairn remarks, "in the selection. Twenty to thirty shillings a ton will make all the difference between good plates and worthless ones, and no plates ought to be used which will not stand an average tensile strain of twenty tons per square inch. The better qualities of plates vary from twenty-two to twenty-five tons per square inch, but well-wrought plates, free from dross and equal to an average test of twenty tons per square inch, will give to the vessel, if well constructed, adequate durability and strength."

In the discussion which followed the reading of this paper, Mr. Scott Russell objected to Mr. Fairbairn's proposal to make the top of the ship as strong and as weighty as the bottom ; Mr. Russell also adverted to the clamour against iron ships, protesting against "the assumption that any ship ought to be, or could be, built so strongly as to stand beating upon rocks in heavy seas, without going to pieces. Mr. Fairbairn would never, he said, get that in this world."

Mr. Grantham went all lengths with Mr. Fairbairn, who, in conclusion, explained that he had no objection to give the bottom of the ship a sufficient excess of strength over the top to provide for any extra wear that might occur there, nor did he contend for the adoption of any specific details by way of improvement. He was only advocating general principles. He believed that some of the modes of construction adopted by Mr. Scott Russell were attended by great and manifest advantages.*

Mr. Fairbairn is an active member of the Royal Society, and in 1860, delivered the Bakerian Lecture, giving a condensed account

* See the abstract of the paper, in the *Year-Book of Facts*, 1861, pp. 41-45.

of his Experimental Researches to determine the Density of Steam at all Temperatures, and to determine the Law of Expansion of Super-heated Steam; the lecturer exhibiting also the apparatus employed, and explaining the methods followed. The Lecturer had for his coadjutor Mr. Thomas Tate: the results show that the density of saturated steam at all temperatures, above as well as below 212°, is invariably greater than that derived from the gaseous laws. It appears that as the steam becomes more and more super-heated, the coefficient of expansion approaches that of a perfect gas. The authors hope that these experiments may be continued, and that the results obtained at greatly increased pressures will prove as important as those already arrived at.

In September last, Mr. Fairbairn occupied the Presidential Chair of the British Association, during their Meeting at Manchester. His inaugural address described in a lucid manner our steady march of inventions and discoveries travelling onwards towards some grand but invisible destination.

He dwelt on the strides made by "Applied Mechanics," a branch of science to which he has contributed so much. The improvements in machinery which owe their origin to him are many and wonderfully various. It was he who made one of the earliest essays in iron shipbuilding, constructing the model vessel at Manchester, and conveying it on wheels to the water-side. He shared with Mr. Hodgkinson the merit of making a most valuable series of experiments on iron-plates and beams. Not that Mr. Fairbairn makes any allusion to these labours; on the contrary, he dwells on the "puddling system" of Cort as the beginning of a new epoch in the manufacture of wrought-iron:

Previously to the inventions of Henry Cort, the manufacture of wrought-iron was of the most crude and primitive description. A hearth and a pair of bellows was all that was employed. But since the introduction of puddling, the iron-masters have increased the production to an extraordinary extent, down to the present time, when processes for the direct conversion of wrought-iron on a large scale are being attempted. A consecutive series of chemical researches into the different processes, from the calcining of the ore to the production of the bar, carried on by Dr. Percy and others, has led to a revolution in the manufacture of iron; and although it is at the present moment in a state of transition, it nevertheless requires no very great discernment to perceive that steel and iron of any required tenacity will be made in the same furnace, with a facility and certainty never before attained.

In iron shipbuilding an immense field is opening before us. Our wooden walls have to all appearance seen their last days; and as one of the early pioneers in iron construction, as applied to shipbuilding, I am highly gratified to witness a change of opinion that augurs well for the security of the liberties of the country. From the commencement of iron shipbuilding in 1830 to the present time, there could be only one opinion among those best acquainted with the subject, namely, that iron must eventually supersede timber in every form of naval construction. The large ocean steamers, the *Himalaya*, the *Persia*, and the *Great Eastern*, abundantly show what can be done with iron, and we have only to look at the new system of casing ships with armour-plates, to be convinced that we can no longer build wooden vessels of war with safety to our naval superiority and the best interests of the country. I am fully persuaded that the whole of our ships *of war must be rebuilt of iron*, and defended with iron armour calculated to *resist projectiles of the heaviest* description at high velocities. In the early *stages of iron shipbuilding, I* believe I was the first to show, by a long series of *experiments, the superiority* of wrought-iron over every other description of

material in security and strength, when judiciously applied in the construction of ships of every class. Other considerations, however, affect the question of vessels of war: and although numerous experiments were made, yet none of the targets were on a scale sufficient to resist more than a 6-pounder shot. It was reserved for our scientific neighbours, the French, to introduce thick iron-plates as a defensive armour for ships. The success which has attended the adoption of this new system of defence affords the prospect of invulnerable ships of war, and hence the desire of the Government to remodel the Navy on an entirely new principle of construction, in order that we may retain its superiority as the great bulwark of the nation.

But our present means are inadequate for the production of large masses of iron, and we may trust that, with new tools and machinery, and the skill, energy, and perseverance of our manufacturers, every difficulty will be overcome, and armour-plates produced which will resist the heaviest existing ordnance. The rifling of heavy ordnance, the introduction of wrought iron, and the new principle of construction with strained hoops, have given to all countries the means of increasing enormously the destructive power of their ordnance. One of the results of this introduction of wrought-iron and correct principles of manufacture, is the reduction of the weight of the new guns to about two-thirds the weight of the older cast-iron ordnance. Hence follows the facility with which guns of much greater power can be worked, while the range and precision of fire are at the same time increased. But these improvements cannot be confined to ourselves. Other nations are increasing the power and range of their artillery in a similar degree, and the energies of the nation must, therefore, be directed to maintain the superiority of our Navy in armour as well as in armament.

To the great "tubular" experiment, Mr. Fairbairn thus becomingly referred :—

We have already seen a new era in the history of the construction of bridges, resulting from the use of iron; and we have only to examine those of the tubular form over the Conway and the Menai Straits to be convinced of the durability, strength, and lightness of tubular constructions applied to the support of railways or common roads in spans which ten years ago were considered beyond the reach of human skill. When it is considered that stone bridges do not exceed 150 feet in span, nor cast-iron bridges 250 feet, we can estimate the progress which has been made in crossing rivers 400 or 500 feet in width, without any support at the middle of the stream. Even spans greatly in excess of this may be bridged over with safety, provided we do not exceed 1800 to 2000 feet, when the structure would be destroyed by its own weight.

To his *collaborateur* in these experiments, who has passed from us within the past year, Mr. Fairbairn renders this touching tribute :—

In leaving this subject, I cannot refrain from an expression of deep regret at the loss which science has sustained through the death of one of our vice-presidents, the late Professor Hodgkinson. For a long series of years he and I worked together in the same field of scientific research, and our labours are recorded in the *Transactions* of this and other Associations. To Mr. Hodgkinson we owe the determination of the true form of cast-iron beams, or section of greatest strength; the law of the elasticity of iron under tensile and compressive forces; and the laws of resistance of columns to compression. I look back to the days of our joint labour with unalloyed pleasure and satisfaction.

Upon a very important branch of Applied Mechanics, Mr. Fairbairn gave this personal evidence :—

It is to the exactitude and accuracy of our machine tools that our machinery of the present time owes its smoothness of motion and certainty of action. When I first entered this city the whole of the machinery was executed by hand. There were neither planing, slotting, nor shaping-machines, and, with the exception of very imperfect lathes and a few drills, the preparatory operations of construction were effected entirely by the hands of the workmen. Now everything is done by

machine tools with a degree of accuracy which the unaided hand could never accomplish. The automaton, or self-acting machine tool, has within itself an almost creative power; in fact, so great are its powers of adaptation, that there is no operation of the human hand that it does not imitate. For many of these improvements the country is indebted to the genius of our townsmen, Mr. Richard Roberts and Mr. Joseph Whitworth.

At the Manchester meeting, the Patent Laws were much discussed; Mr. Fairbairn, in his Address, having given this manly rebuke to the President of the Society of Mechanical Engineers for his attack upon the patent system. He said:—

It is asserted by those who have done the least to benefit their country by inventions that a monopoly is injurious, and that, if the patent laws are defended, it should be, not on the ground of their benefit to the inventor, but on that of their utility to the nation. I believe this to be a dangerous doctrine, and I hope it will never be acted upon. I cannot see the right of the nation to appropriate the labours of a lifetime, without awarding any remuneration. The nation, in this case, receives a benefit; and, assuredly, the labourer is worthy of his hire. I am no friend of monopoly, but neither am I a friend of injustice: and I think that before the public are benefited by an invention, the inventor should be rewarded either by a fourteen years' monopoly, or in some other way. Our patent laws are defective, so far as they protect pretended inventions; but they are essential to the best interests of the State in stimulating the exertions of a class of eminent men, such as Arkwright, Watt, and Crompton, whose inventions have entailed upon all countries invaluable benefits, and have done honour to the human race.

Upon this, the Editor of the *Mechanics' Magazine* forcibly remarks:—"Mr. Fairbairn has always borne the reputation of an honest man, who would not appropriate, without payment, the fruits of other men's labours, or by any means pilfer or pirate inventions."

To the other topics touched upon broadly by the President, in his address, we have adverted incidentally in the present *Year-Book.*

In October last, Mr. Fairbairn was present at the opening of the School of Science at Liverpool, when in the course of his interesting address he thus referred to the great improvements in steam:—

As a labourer in the field of science, more particularly practical science, I am sure you will allow me to give you a few examples of the great advantages which the industrial arts receive from the exact sciences, and particularly from those constructions which are of much greater advantage to the industry and property of the community. With regard to steam, I am quite sure every person here present must be aware of the very great advantages of that source of power, that immense power we see daily before us; and if we look back to the days since James Watt lived to the present time, everybody will be convinced of the great improvements that have taken place by the application of science to that particular element. I recollect well, in the early part of my own history, that the steam-engine never worked above 7 lb. to 8 lb. upon the square inch; it then reached 20 lb.; then 50 lb. But now, if we look at the locomotive engine, the pressure is upwards of 150 lb. and even 200 lb. upon the square inch. This is a great advantage, and if we may judge by the great improvements which are taking place with regard to the steam-engine, the locomotive as well as the condensing engine, I am inclined to think that we are not by any means arrived at the full economy of the production of steam in this country and all other countries. Instead of working at the rate of 200 lb. upon the square inch, I think it is very likely it will reach 500 lb.

Our great Engineer in Iron has written a Treatise upon "its *History, Properties, and Processes* of Manufacture," for the eighth

edition of the *Encyclopædia Britannica*. This comprehensive paper has been revised and republished, in a more complete form, in a volume. It treats of the various processes of manufacture, and of what relates to the chemical and natural history, statistics, &c., of iron, but not to its appliances, which important subject has already, to a certain extent, been separately illustrated by the author. In an appendix on Armour-plated Ships, Mr. Fairbairn expresses it as his opinion, that the whole navy of Great Britain must be remodelled and rebuilt of iron,—in framework no less than in armour; and in the same appendix the author draws particular attention to a new and important branch of the iron manufacture which he considers will, in all probability, shortly come into existence,—namely, the production of wrought-iron in very large masses.

Mr. Fairbairn, in October last, resigned his office as one of the Vice-Presidents of the Manchester Literary and Philosophical Society. He is a Corresponding Member of the National Institute of France; and at the late anniversary of the Royal Society, he was elected to the Council. To the approaching International Exhibition, Mr. Fairbairn contributes his valuable aid as a member of the Building Committee; of the Sub-Committee of Sanitary Appliances; and of the Military Committee,—Military Engineering, Armour, and Accoutrements, Ordnance and Small Arms.

The accompanying Portrait, from an admirable Photograph by Messrs. Hills and Saunders, Oxford, has been engraved by their special permission.

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THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

BUILDINGS FOR THE INTERNATIONAL EXHIBITION, 1862.

THE Great Exhibition of 1851, a work of unparalleled labour and correspondent success, must be considered as the parent of the approaching International Exhibition in 1862. It is difficult to apportion to each individual concerned in originating the Exhibition of 1851, his respective share of merit; but the *International* character was exclusively the suggestion of the late Prince Consort, who, unhappily, has not been spared to witness the consummation of the Second Exhibition, which, as regards its International feature, must be regarded as an extension of His Royal Highness's portion of the earlier design; such extension consisting, principally, in its Section of Modern Fine Arts, which is to include Architecture; Paintings in Oil and Water Colours, and Drawings; Sculpture, Models, Die-sinking, and Intaglios; and Engravings and Etchings. Hence, the coming Exhibition is more properly termed "of Works of Industry and Art." We shall here say no more of the scope or general plan of the International Exhibition; our present object being to describe the Buildings which have been provided for this magnificent display.

We all well remember the difficulties which beset the provision of the Building for the Exhibition of 1851: how a most unsightly design was accepted, but very properly superseded by "the palace of glass," which sprung from the genius of Mr. (now Sir Joseph) Paxton. Well do we remember the magic effect of our first sight of the outline of Mr. Paxton's design: it was merely a light outline upon a large surface of bank-post paper, and the instant Mr. Paxton spread out the sheet, we exclaimed—"It is like a fairy palace!" The vast building in Hyde Park fully realized this idea, though somewhat enthusiastically expressed; and it has ever been a source of satisfaction to reflect that he who was thus instantly impressed with the graceful character of Mr. Paxton's design was the first to express such an opinion of its novelty and appropriateness in one of the public journals of the next day.

In the *Year-Book of Facts*, 1851, we devoted eleven pages to the details *of the Great Exhibition* Building, concluding with these

emphatic, and, in some respects, prophetic opinions, of Professor Cowper:—

I look upon the original idea of Mr. Paxton as one of the most successful efforts of imagination and contrivance, and I consider the way in which Fox and Henderson have made the bold conception *practicable*, one of the most successful and astonishing examples of contrivance, tact, science, industry and perseverance, and engineering skill, the world ever saw; and, whatever wonders may hereafter be placed in this building, *the structure itself will be the greatest wonder of all.*

We have now to deal with the Building for the International Exhibition of 1862. The design has already been so much canvassed, that we propose to confine ourselves principally to the descriptive details of the Buildings, derived from the published official Account. The first important step taken by the Commissioners was generally considered an unwise one. "Without any appeal for suggestions to the country in general (said a journal of the day), or to the architectural profession in particular,—without a hint to the guarantors of the fund to provide against loss, or even a single note of preparation, the public suddenly learn that the design is agreed on, the plans laid, the specifications written, and that tenders for the erection of the building are being sought for. Sir Joseph Paxton has already pointed out, in a letter to the *Times*, together with his objection, as a guarantor, to the looseness of the conditions, and to spending so large a sum as this building would require (say a quarter of a million), the fact that a fair estimate of the cost cannot possibly be made in the few days given, and that the person who tenders for the erection of the building 'must do so at great risk, unless he has been so fortunate as to have had access to the plans before they were given to the public.' We fully endorse the correctness of this assertion."—*Builder*, Feb. 9, 1861.

However, these objections were overruled; and the design by Captain Fowke, of the Royal Engineers, was declared to be accepted. The situation is to the south of the plot of ground occupied by the Horticultural Society's new gardens at South Kensington. The southern façade of the new building runs along the Cromwell-road, a few hundred feet from the South Kensington Museum; on the east, also with a front, lies the Exhibition-road; on the west, Prince Albert's-road; between this and the Horticultural Society's boundary, a semi-detached portion of the Exhibition building, intended for the department of implements and machinery in motion, extends; to this has been given the name of the *Annexe.*

The Commissioners* resolved that the new building should be formed of more weather-tight materials than iron and glass, at least in those portions devoted to the reception of works of Art. Accordingly, a very large portion of the new construction is of brick, the roofs supported on cast-iron pillars, the roof itself of wood, protected by felt and painted. Thus much for the materials.

* The Commissioners are, the Earl Granville, the Duke of Buckingham, Mr. Thomas Baring, M.P., Sir C. W. Dilke, Bart., and Mr. Thomas Fairbairn.

The following statistics are from the official account.*

The buildings cover in the whole more than 26 acres. The principal picture gallery, which is in Cromwell-road, is 1150 feet long, 50 feet wide, and 50 feet high above the ground-floor; being about as long as the Gallery at the Louvre in Paris. The construction of this is of brickwork. The piers at the entrance are 14 feet wide, and 7 feet thick; and the foundations throughout are of concrete 5 feet thick. The walls are lined with wood, and pictures may be hung, if desired, to a height of 30 feet. It is lighted like the Sheepshanks Gallery. The entrance to this Gallery in Cromwell-road, is through three very large recessed arcades, each 20 feet wide, and 50 feet high. The visitor enters a vestibule and hall, 150 feet long, and together 110 feet wide, which leads to the Industrial Halls and Galleries; whilst two flights of steps, 20 feet wide, lead on either side up to the Picture Galleries. The Auxiliary Picture Galleries are in Prince Albert's and Exhibition-roads. These are 25 feet wide and about 30 feet high, and jointly 1200 feet long.

The Industrial Buildings, constructed chiefly of iron, timber, and glass, consist of the following parts:—Two duodecagonal domes, which will be 160 feet in diameter, and 250 feet high,—the largest of ancient and modern times. The dome of the Pantheon is 142 feet in diameter and 70 feet high; the dome in the Baths of Caracalla was 111 feet; Brunelleschi's, at Florence, is 139 feet in diameter and 133 feet high; the dome of St. Peter's is 158 feet in diameter, and 263 feet high from the external plinth; the dome of St. Paul's Cathedral is 112 feet in diameter, and 215 feet high. The domes will be of glass, with an outer and inner gallery; and it has been proposed to erect one of Messrs. Chance's dioptric lights at the top of one of them, and to illuminate it at night. The vista from dome to dome, through the nave, is 1070 feet. Each of the domes springs from the intersections of the nave with the two transepts. The nave and transepts are 100 feet high, and 85 feet wide; the nave is 800 feet long, and the transepts are each about 635 feet long, including the domes. They are lighted on both sides by clerestory windows, 25 feet high.

At 25 feet from the ground a gallery runs at each side of the nave and transepts. There is more than a mile and a half of upper galleries, some 50 feet and some 25 feet wide; two courts, each 250 feet by 86 feet; two courts, each 250 feet by 200 feet; two central courts,—that at the north 150 feet by 86, that at the south 150 feet by 150 feet. All these glass courts are 50 feet high, and lighted from above.

The entrances to the Industrial Buildings are in Prince Albert's-road and Exhibition-road. They are constructed in brick, and each entrance is 55 feet wide.

A bed of gravel underlies the whole ground. The foundations have been excavated to the gravel, and a base of concrete put in, on which brick piers, with York stone slabs, have been placed to receive the iron columns. The slabs for the columns of the great domes weigh upwards of a ton. The bricks are from Kent, and have been supplied by Messrs. Smeed, of Sittingbourne. Upwards of ten millions have been used.

The iron castings, as we have before now stated, were executed at the Stavely Iron-Works, Derbyshire. There are 166 round columns for the nave and transepts 12 inches in diameter, connected with a like number of square pilasters; 312 eight-inch round columns and 149 twelve-inch square columns, for the galleries; 138 eight-inch square clerestory columns, and 160 ten-inch square columns, supporting the floors of the Picture Galleries; 62 round columns for supporting the roofs of the glass courts; 1165 girders throughout, 11,600 feet of pipes, 15,000 feet of gutters, 14,000 feet of railings, 1000 brackets, 700 trusses and girders, 1400 shoes, &c.: the whole is estimated to weigh nearly 4000 tons.

The wrought-iron is supplied by the Thames Iron Company. This will be used chiefly in the great domes, and for the roofs. It is estimated to weigh about 1200 tons. The bracings, trusses, railings, bolts, &c., are made by the contractors. Mr. Ashton, who fixed the iron-work for Sir Joseph Paxton's two

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* *Some Account of the Buildings designed by Francis Fowke, Capt. R.E., for the International Exhibition of 1862, and Future Decennial Exhibitions of the Works of Art and Industry.* With Illustrations and a Map of the Site. London: *Chapman and Hall. 1861.*

glass buildings, is charged with the same duty here. The timber-work has been executed partly at Messrs. Lucas's works at Lowestoft, and partly at Mr. Kelk's works at the Grosvenor Canal. It is estimated that about 17,000 loads will be consumed. For the top lighting of the galleries, 45,000 feet superficial of frames and glass are in preparation. For the clerestory lights of the nave and transepts nearly a mile length of frames, 25 feet high, is preparing; and for the courts, upwards of 30 miles of sash-bars and glass.

The roofs are covered with slates for the great Picture Galleries, and elsewhere with felt, except in parts, to show how ornamental roofing may be hereafter applied. The contract for the whole works has been let to Messrs. Kelk, and Charles and Thomas Lucas, Brothers, whose tender was the lowest. The whole responsibility for the nature and execution of the works rest with them. Mr. Meeson, C.E., prepares the working drawings for them. All proceedings are submitted to Capt. Fowke, R.E., who acts for Her Majesty's Commissioners. He confers with a building committee, consisting of the Earl of Shelburne, Mr. W. Fairbairn, and Mr. W. Baker; and her Majesty's Commissioners reserve to themselves the final approval of everything. Captain Fowke is assisted by Captain Philpotts and Lieutenant Brook, and certain non-commissioned officers of the Royal Engineers. Mr. Clemence is the contractors' foreman of works. The contract, it will be remembered, is of a threefold character: for the use and waste of the buildings, a sum of 200,000*l.* is to be paid absolutely: if the receipts exceed 400,000*l.*, then the contractors are to take up to a further sum of 100,000*l.*; and if this sum is fully paid, then the centre acre of the great Picture Galleries is to be left as the property of the Society of Arts, who will pay the "1851" Commissioners a ground-rent calculated at the rate of 240*l.* per acre per annum. Lastly, the contractors are bound to sell absolutely the remaining rights over the buildings for a further sum of 130,000*l.*, which may possibly be paid by the surplus receipts of the Exhibition, if the success be great, of which there can scarcely be a doubt.

Comparing the extent of the present Building with that in 1851, —the latter occupied nearly 23 acres; that now erecting covers a little over 26. The flooring space in 1851 was just short of a million feet. In the new building there will be 1,140,000; but as it is intended to exhibit machinery and agricultural implements in a wing especially built for the purpose, the space occupied in 1851 by these classes will be at the disposal of the Commissioners for other works, so that practically there will be some 500,000 feet of flooring more in 1862 than in 1851. The greatest height in 1851 was 160 feet, and the main nave running from end to end was 60 feet high by 72 wide. The greatest height of the new building will be 260 feet, and the nave will be 1200 feet long by 85 wide, and 100 feet high. The total length of the first Exhibition building was 1800 feet by 400 wide. The dimensions of the present are to be 1200 long by 700 broad, exclusive of the space set aside for the display of agricultural implements, which is in rough numbers 1000 feet long by 220 broad.

We all must feel a twofold interest in the success of the International Exhibition: as a display of those humanizing arts which so widely exalt and embellish life—and as a fitting memorial of "respect to the Prince who made the scheme of international exhibition his own."

THE FLORENCE EXHIBITION.

THE first Italian Exhibition of Art and Industry was opened at *Florence* in September last.

The impression produced by a glance over the contents is that

Italy from her own arts and manufactures is capable of supplying, more or less perfectly, the requirements of an enlightened and refined people, although assuredly she at present seems to excel far more in articles of luxury than in those of first necessity. Her excellence in wood-carving and inlaying far surpasses that of her ironwork and earthenware, and her silks and velvets have made greater progress than her sewing-cotton and linens. Of all the greater branches of Italian industry, the silk-manufactory is perhaps the most largely represented, as might naturally be expected. A great space is filled with its products, both raw and manufactured, from almost every part of the Peninsula. The silk-growers of Upper Italy appear to bear away the palm from all their rivals in the quality of their raw silk, both white and yellow; and that produced by the Romagna seems the most inferior, both in colour, strength, and richness. Among the manufactured specimens, the furniture brocades turned out by the looms of Piedmont and Lombardy, and some of those sent from Naples, are of a splendour, both for design and quality, which halts but a little, if at all, behind the manufactures of Lyons. Gold and silver *moire*, and gold-brocaded silks for church vestments, too, are among the most advanced branches of this industry. The linens and damasks for table use, although very far behind what England can show in beauty of finish, are yet in all respects very promising. Tuscany furnishes a great quantity of the best goods of this kind, as well as all the varieties of towelling, sheeting, &c., less tempting to look at, but more reasonable and far more durable than ours. The display of ribbons does not rise above a very humble mediocrity in either colour, pattern, or quality. Versatile Naples has contributed products of all kinds to the National Exhibition. Pianos, carriages, silks, linens, hemp cloths, and a dozen more kinds of manufactured articles, besides a very beautiful though not very numerous display of wrought coral ornaments, which, with singular bad taste, have been crowded into two lower shelves of a sort of glazed *étagère*, where they make no appearance whatever, and where numbers of visitors never discover them at all. Nothing can exceed the elegance of the bracelets, brooches, and other ornaments of mixed red and white, or of pale rose-coloured coral, worked with infinite taste into knots, posies, and cameos of rare delicacy and finish. The Florentine and the Roman mosaics, handsome as they are, look heavy and graceless beside this exquisite manufacture.

The show of jewelry is chiefly from Turin and Milan, and though it contains some handsome gems, the visitors of French or English Exhibitions will hardly think it worth a glance. Not so the beautiful sword presented to the King by the Modenese citizens, which lies in the same room. The rich chasing of the entire scabbard is worthy of the best days of Mediæval Art, and the hilt is adorned with a small silver statue of Italy in jewelled and enamelled robes, and the top of her diadem formed of a single fine emerald.

THE INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following Premiums for papers read during the Session 1860–61 :—

A Telford Medal, and a Council Premium of Books, to W. H. Preece, for his paper "On the Maintenance and Durability of Submarine Cables in Shallow Waters,"—a Telford Medal, and the Manby Premium, in Books, to G. P. Bidder, Jun., for his paper "On the National Defences,"—a Telford Medal, to F. Fox, for his paper "On the Results of Trials on Varieties of Iron Permanent Way,"—a Council Premium of Books, to F. Braithwaite, for his paper "On the Rise and Fall of the River Wandle; its Springs, Tributaries, and Pollution,"—a Council Premium of Books, to G. Hurwood, for his paper "On the River Orwell and the Port of Ipswich,"—a Council Premium of Books, to W. Hall, for his paper "On the Floating Railway at the Forth and Tay Ferries."

The Council has fixed upon its lists of subjects for Premiums during the Session 1861–2. The list contains fifty-six subjects in engineering. An innovation on the usual practice will be introduced: that of pecuniary rewards not exceeding in each case twenty-five guineas, in addition to the honorary premiums, in a few specical and important cases. Five such cases are named in the list :—

"On Reclaiming Land from Seas and Estuaries;" "Accounts of existing Water-works, showing the Methods of Supply, the Distribution throughout the Streets of Towns, and the general practical results;" "On the Results of the Use of Tubular Boilers, and of Steam at an increased pressure, for Marine Engines, noticing particularly the difference in weight and in speed, in proportion to the Horse Power and the Tonnage;" "On the Form and Materials for Floating Batteries and Iron-plated Ships;" and "Railway Accidents—their causes and means of prevention, showing the bearing which existing legislation has upon them."

SOCIETY OF ARTS.

ON the first ordinary meeting of the hundred and eighth session, Sir Thomas Phillipps, F.G.S., chairman of the Council, presided, and delivered an address, in the course of which he said, that as the International Exhibition buildings were susceptible of much decoration, it was thought desirable to originate a subscription for the purpose of making experiments in the employment of mosaics on the external walls of the front in Cromwell-road. The subscription was begun by Earl Granville; the mosaics would give to the buildings a character new in this country.

At the close of his address, the chairman presented the medals awarded by the Council at the close of the session to the following gentlemen :—

To Dr. Edward Smith, F.R.S., for his two papers, "Recent Experimental Inquiries into the Nature and Action of Alcohols as Food," and "On the Uses of Tea in the Healthy System." The Society's Silver Medal.

To A. K. Isbister, for his paper "On the Hudson's Bay Territories; their Trade, Productions, and Resources; with Suggestions for the Establishment and Economical Administration of a Crown Colony on the Red River and Saskatchewan." The Society's Silver Medal.

To Alexander Redgrave, for his paper "On the Progress of the Textile Manufactures of Great Britain." The Society's Silver Medal.

To Dr. Milligan, for his paper "On Tasmania; its Character, Products, and Resources." The Society's Silver Medal.

To Charles Ledger, for "The Introduction of the Alpaca into the Australian *Colonies.*" *The Society*'s Silver Medal.

To F. Joubert, for "The Application of Photography to the production of *Images on Glass, which* can be burnt in." The Society's Silver Medal.

A NEW GUN-METAL.

It is well known that caloric promotes the decomposition of iron, by reason of its counteracting the attraction of cohesion which exists in it, and that through long-continued firing of cannon its elasticity becomes destroyed. Mr. James Bruce recommends as a New Gun-Metal the admixture of *platina* with iron for the following reasons :—1. This metallic compound produces the *hardest* description of iron yet known, having very little affinity for caloric, by which its cohesion and elasticity are preserved throughout. 2. The oxygen of the atmosphere (or the acids of paints, &c.) have no effect on it, consequently the metal will be more durable, and less liable to bursting. Many accidents no doubt arise from the highly-oxidized condition of cannon, as the metal is then more friable, pulverulent, and brittle. (Cannon should be "*weighed*" every year, and a note taken of the *increase* in its weight as a precaution against their bursting. The increase in weight, which the cannon acquires, is always equal to the weight of the oxygen absorbed.) Platina resists the strongest heat of our fires without melting, and, like iron, is capable of being welded when properly heated. It may, however, be melted by a burning lens; or, if it be mixed with *arsenic* and exposed to a great heat, it fuses readily. (*Caloric*, likewise, promotes the oxidizement of cannon metal.) In the Tower is to be seen a two-pounder, taken in 1798, made of a metal, or mixture of a metal, strongly resembling *gold*. Probably it is an alloy of gold and iron.—*Mechanics' Magazine.*

WROUGHT-IRON OR CAST-IRON FOR GUNS?*

Sir W. Armstrong observes, upon this important question :—

Up to the present time, cast-iron has been almost exclusively employed in the construction of heavy ordnance; but guns made of that material have not been found adequate to resist the more severe strain incident to the use of elongated rifled projectiles. This inadequacy of strength becomes the more decided as we increase the magnitude of the gun; and since a growing demand exists for more powerful artillery, the use of cast-iron for its construction seems to be entirely precluded. It is said, and I believe with truth, that in America the manufacture of cast-iron ordnance has been so far improved by applying water to cool the casting from the interior as to enable serviceable guns of this material to be produced of much larger bore than have been made in England. But it appears that these guns have not been rifled, and are only intended to be used with hollow projectiles. This success, therefore, affords no reason for coming to a different conclusion as to the unfitness of cast-iron for the construction of rifled guns designed to project solid shot, especially when the dimensions are large. Even when strengthened by wrought-iron hoops, the tendency of cast-iron in a gun is to become weaker by every succeeding discharge. This is owing to minute fractures occurring in the bore, generally in the vicinity of the vent, and gradually extending until they terminate in the rupture of the gun. If, therefore, cast-iron guns are to be utilized at all as rifled ordnance, it can only be by confining their use to hollow projectiles and light charges; but if the same indulgence were extended to wrought-iron guns, equal efficiency would be obtained with half the weight of metal, and on this ground alone the superiority of the latter is decisive. Wrought-iron, made either from "bloom" or "puddled ball," must necessarily consist in the first instance of a congeries of welds or joinings. The smaller the mass and the more it is reduced under the rolls or hammer, the more perfectly will it be united, but when a large block is forged from an aggregation of blooms,

it is almost impossible to render it homogeneous throughout. The flaws in such a forging will generally be drawn out by the process of hammering in the direction of the length, and will therefore not materially affect its strength in reference to longitudinal strains. But if the mass be subjected to an explosive force acting from the interior, as in a gun, the presence of such flaws becomes fatal. Wrought-iron, therefore, applied as a solid block to the construction of guns, I hold to be even more objectionable than cast-iron, for, although a wrought-iron gun thus made, if it happen to be sound, may possess greater powers of resistance, yet it must always be more subject than cast-iron to concealed flaws, and on that account be more uncertain and treacherous.

If iron, after its conversion to the malleable form, could be fused, all welds would be obliterated, and the mass rendered uniform throughout. Such a material would merit the appellation of "homogeneous iron," but the metal which now bears that name is of a different nature, being merely a species of cast-steel. The crystalline form assumed by steel in solidifying from the liquid state always renders the material in the first instance hard and brittle, and it is only under the subsequent process of hammering that it acquires ductility and toughness. This alterative process of hammering is perfectly effectual when the thickness of the steel is small, but when it is required to be forged into a large mass it appears to be a matter of the utmost difficulty to effect the required change. It is seldom that the enterprise of English manufacturers is exceeded by that of foreigners, but in the production of steel forgings of large dimensions, Krupp, of Essen, has taken the lead of all steelmakers in this country. He has met the difficulty of toughening large masses of cast-steel by using hammers of extraordinary weight, and I believe that equal success will never be attained in England without adopting similar measures. It will be a great era in metallurgy when a material possessing the toughness and ductility of wrought-iron, combined with the homogeneous character of a cast metal, can be economically supplied in large blocks.

The preceding observations on the application of iron to the construction of artillery would not be complete without some allusion to the system of manufacture which I have myself adopted, and which may be designated the coil system. When malleable iron is rolled into bars, its crystallization assumes a fibrous form, causing the bar to resemble a bundle of threads, strongly adhering to each other, but possessing their chief tenacity in the direction of their length. The compressive power of the rolls is also such as generally to eliminate all imperfect welds, or, if any remain, they are drawn out parallel with the fibre of the iron. To realize in a cylinder the advantage of this fibrous structure it becomes necessary to coil the bar into a spiral, and to unite the folds by welding. The lines of welding will then be transverse to the cylinder, in which direction they have little tendency to weaken it when exposed to a bursting force, even should they not be perfectly sound. There is a limit to the thickness of bar, which it is convenient to bend into a spiral, and in making a gun on this system the required diameter is made up by applying successive layers of coils, each layer being shrunk upon the one beneath. This mode of construction has the advantage of affording the opportunity of discovering and rejecting all defective parts as the work proceeds; and guns may thus be built up to almost any size without encountering any of those difficulties and liabilities which are met with in forging large blocks, whether of steel or iron.

With regard to the great question of the ultimate effect of artillery against ships protected by defensive armour, I believe that, whatever thickness of iron may be adopted, guns will be constructed capable of destroying it. At the same time I am of opinion that iron-plated ships will be infinitely more secure against artillery than timber ships. The former will effectually resist every species of explosive or incendiary projectile, as well as solid shot from all but the heaviest guns, which can never be used in large numbers against them. In short, it appears to me to be a question between plated ships or none at all; at any rate, so far as line-of-battle ships are concerned. With respect to the quality of the material best adapted to resist the impact of shot, this subject is engaging much attention in the town of Sheffield and the iron districts generally. So far as my own observation and experience go, I may say that hardness and lamination are the conditions most essential to avoid. In striking a plate the tendency of a shot is to fracture, rather than to pierce, the material. When penetration is effected the hole is of a broken character, and not such as would be made by the cutting action

of a punch. The softer, therefore, the iron, the less injury it will sustain, and I apprehend that steel, in every form, will, from its great hardness, be found less effective than wrought-iron, while its cost would be very much greater. As regards lamination it has been clearly ascertained that a given thickness of iron made up of successive layers of thin plates is very much weaker for the purpose of armour than the same thickness in the solid form. But a laminated plate, by which I mean a plate having the layers composing it imperfectly united, must be regarded as an aggregation of separate plates, so that the strength derived from continuity is wanting. If this tendency to lamination could be obviated, rolled plates would, in my opinion, be preferable to forged, since the iron would acquire a more fibrous condition, but the existence of this liability appears to turn the scale in favour of forging.—*Proceedings Instit. Mechanical Engineers.*

MARTIN'S LIQUID IRON SHELLS.

EXPERIMENTS have been made on these instruments of destruction. Upwards of 2000 have been supplied to the principal batteries in the Chatham district, and to the defences at the entrances of the River Medway. Cupolas for melting the iron have been furnished to two or three other stations. The cupola for preparing the molten iron with which Martin's shells are charged, consists of a cylindrical shell of thick wrought-iron, lined with prepared fire-bricks, with a blast-fan attached. The cupola and fan are mounted on a frame furnished with four travelling wheels, each of which is 24 inches in diameter. An apparatus contrived for driving the fan by manual labour is connected with the cupola when in use, by two tie-rods, each about 11½ feet in length; but these are removable, so that when in motion the cupola and driving apparatus are entirely separate. The driving gear of the fan is so constructed that, whenever steam power is available, it can at once be applied, instead of manual labour—Aveling's portable agricultural steam-engines, and others of the same kind, being well adapted for this purpose. When the blast-fan is driven by manual labour, eighteen men are required to work it, with short reliefs. In about twenty minutes after the fire in the cupola is lighted the iron is put in, and in about a quarter of an hour after the fan has been put in motion the molten iron can be run off into the shells. A ton of metal can be melted in about thirty minutes. Allowing, therefore, for waste, the number of shells that can be filled in one hour is 140 of the 8-inch 68-pounders, and the same number of the 10-inch 96-pounders. The estimated weight of the machine is 4 tons 13 cwt.—*Mechanics' Magazine.*

RIFLED ORDNANCE.

MR. WHITWORTH, in a letter to the *Times*, gives the following corrective details of his Rifled Ordnance:—

"I have supplied to the Admiralty only one heavy gun, a breech-loader, having a 5½ inch bore. It was publicly tried at Southport in February, and again in August, last year, giving results which remain, I believe, still unsurpassed. The same gun was tried at the Nore, in the presence of the Lords of the Admiralty, in May, 1860. It successfully fired its shot through both the armour-plates and side of the *Trusty* floating battery. After having been severely tested

during a year's experimental firing with complete success, the gun passed out of my hands and was delivered to the Government. It was sent down to Portsmouth, and, after a short series of experiments had been made with it there, the inner tube was cracked a few inches in front of the part occupied by the powder charge.

"A Commission was appointed by the Government to report upon the injury, and they gave it as their opinion that it had been caused by the gun being fired with the projectile away from the powder, which will infallibly injure any gun. It should be explained that the inner tube I have mentioned is of homogeneous metal, which, by proper treatment, may be made of any required temper.

"The blade of a sword, it is well known, if left too hard, is brittle, and snaps; if tempered too soft, its edge wears away, or bends; but a suitable medium temper may be readily given to answer the required purpose. In like manner, in employing homogeneous metal for rifled guns, experience alone can determine what is the proper temper. It must be hard enough to resist wear and the action of the gases of explosion, which are so destructive to soft wrought-iron, and yet not so hard as to cause the metal to crack, instead of bulge, when a pressure greater than it is calculated to bear is made to act upon it.

"There is no doubt that the temper of the inner tube that was cracked at Portsmouth was too hard. The gun was subjected to a very severe and unusual strain, when fired with an air space in front of the powder charge (a very different thing from air space at its side); but if the temper had been softer the injury would have manifested itself by a considerable enlargement or bulge, instead of a crack.

"It must not be taken for granted that because homogeneous metal has been found in some cases to yield unexpectedly, its character is too uncertain to be depended upon. The success of Mr. Krupp has shown the good effect of proper forging; this combined with a careful and experienced system of annealing, so as to give the proper temper will, I believe, remedy all the difficulties that have attended the use of this metal when employed in large masses.

"In 1856 I advocated, as I still do, the employment of the simple muzzle-loaders for field artillery. It was proved, then, by the brass guns I rifled for the Government, as it may be proved now by publicly trying them, that it is a grave error to overlook the many advantages offered, both for land and sea service, by the muzzle-loading rifled brass guns. But at that time the breech-loader was considered to be the great desideratum, and the practicability of firing simple hard-metal projectiles, in contact with a simple metal bore, was so much doubted that the lead-coated shot was preferred, notwithstanding the complication of its construction and its much greater cost. For, without taking into account the value of equal quantities of cast metal used in both kinds of projectiles, the cost of the compound lead-coated shot is more than six times that of the simple polygonal shot."

THE WHITWORTH GUN.

EXPERIMENTS have been made at Shoeburyness, before Lord Palmerston, to enable his lordship to judge for himself as to the merits of the Whitworth Gun :—to ascertain if it could be manipulated with that ease which, supposing any other objections against it were removed, might render it not only a serviceable battery but field-gun. For this purpose several rounds were fired from the 70-pounder, from the two 12-pounders, and from the brass rifled gun. The result was a perfect admission on the part of those present that the trials had been thoroughly satisfactory. Mr. Whitworth was present, and received the congratulations which the occasion merited.—*Army and Navy Gazette.*

NEW SYSTEM OF RIFLING.

COMMANDER SCOTT, R.N., has explained to the Institution of Civil Engineers his own System of Rifling, which can be applied easily and cheaply to an ordinary 32-pounder. It consists of three grooves, each caused by an increasing width of a third of the bore, and a return to the original circumference by an angle or notch. The shell made to fit this rifled bore is of iron, without any covering of lead, and it cannot be introduced into the gun without a correct relation to its grooves. In fact, the notches on the sides of the projectile fall into their places in the easiest possible way, when the gunner lifts it to the muzzle. He exhibited a shell of his construction, which weighed thirty-six pounds, or, with its charge of powder, about forty pounds ; and this had been fired eight or nine times with scarcely any perceptible injury. It was of great importance in the attainment of velocity to use a light shell, as the strain on a gun must be in proportion to its inertia. The reason of round shot having the advantage at a short range was, that it left the gun with the most favourable possible motion, namely, revolving on its horizontal axis.

A NEW RIFLE.

MR. REEVES has patented a Rifle, to be used as a breech-loader or ordinary muzzle-loader. The peculiar advantage of this weapon is the simplicity of its arrangement. The breech end of the barrel is a solid piece of metal, fixed in the stock with a breech-pin, while the other part is secured by bands after the plan adopted for the Government rifles as the result of many experiments. The aperture in which the cartridge is placed has a sliding cover. When the cartridge is inserted in the aperture, the action of closing it is of the most simple character ; the slide is pressed forward with the palm of the hand, and then turned down sideways so as to cover the opening. The operator then finds his thumb in the best position for drawing back the hammer, previous to putting on the cap ; but another important result has also been obtained by this apparently simple, but very ingenious contrivance. There is a slight inclination at the back end of the plunger, and by the side movement which closes the aperture in the breech, the plunger is made to fit the

cavity with such nicety that no gas from successive discharges can possibly get into the chamber, which thus remains air-tight and perfectly clean. The rifle can be loaded and fired nine or ten times a minute with perfect ease. The power of the weapon is something terrible: we saw put up a case containing forty-two half-inch deal boards, and a bullet fired at a range of thirty yards went smashing through all the planks, and was then crushed flat against an iron target, which it struck with tremendous force. It has been calculated that at a distance of 500 yards a bullet fired with accurate aim from one of these rifles would go through the bodies of six men standing behind each other. With the new rifle of Mr. Reeves, armed with which a man may, from behind any object large enough to cover his own body, load and fire nine times a minute without hindrance and without exposing himself to the enemy in the slightest degree. There is also another material advantage to be noticed, and that is the capacity of the rifle for instantaneous adaptation as a muzzle loader. If regular cartridges cannot be obtained, it only needs that a small plug should be placed in front of the plunger, and the breech aperture closed, and wherever loose powder and lead are obtainable, the holder of one of these rifles would still possess a safe and effective weapon. As regards the essential points of strength, security, simplicity of arrangement, and ease and quickness of firing, this rifle may take its place amongst the best yet submitted to public notice.—*Aris's Birmingham Gazette.*

NEW BREECH-LOADING RIFLE.

A VERY fine piece of ordnance, constructed on a new breech-loading principle by Messrs. Wheatley Kirk and Co., engineers, Manchester, has been tested. The gun is manufactured of patent puddled iron; it weighs 9 cwt., and is 7 feet long, with a 3-in. bore and 12-lb. calibre. The breech combines a variety of important improvements, by which all blowing out of the vent or breech part is rendered impossible, and a great rapidity of loading is obtained. The forgings were made by the Mersey Steel and Iron Company. This new piece of ordnance is somewhat less in size than Mr. Whitworth's homogeneous iron 12-lb. breech-loader, and while the outline of the instrument is beautifully symmetrical it is evidently a most formidable weapon. It is mounted on a patent steel gun carriage and limber of an extremely light construction and elegant design, rendering this gun one of the most manageable and portable of any at present in use. In the experiments about a dozen charges were fired, the range being one mile, and, although the sighting was not directed by a regular military man, the average elevation was 5 degrees, with a charge in each case of 1¾ lb. of powder, giving a range of 1760 yards, with a deflection of each shot as follows:—No. 1, on the line; 2, 1 *yard to the left; 3,* 1 yard to the right; 4, 1 yard to the left; *5, 1½ yard to the left; 6,* ½ yard to the left; 7, on the line.

THE EDINBURGH TIME-GUN.

The daily Time-Gun at Edinburgh Castle has, after two failures, been brought into successful operation, in the presence of between 200 and 300 gentlemen assembled at the Observatory on the Calton-hill, in expectation of witnessing the simultaneous dropping of the time-ball on Nelson's monument, Calton-hill, and the firing of the time-gun from the Castle, three-quarters of a mile distant, by means of the telegraph wire suspended in one stretch over the entire distance. The company included Sir W. G. Craig, chairman of the Observatory Board, Professor Smyth, Astronomer-Royal for Scotland, Sir William R. Hamilton, Dublin, Professor W. M. Ranken, Glasgow, &c. The time during the last half-minute was told at the Observatory door, and the company were informed that the flash of the gun would be observed at the precise moment the time-ball fell, and that four seconds later the report would be heard. Unfortunately the eager spectators were disappointed, for though the time-ball fell there was neither flash nor sound. In less than a quarter of an hour a messenger arrived from the Castle to announce that the fuse or friction tube had missed fire. The fuse employed is the one ordinarily used in artillery practice, and, though about sixty had been fired in the experimental trials, not one had hitherto failed. That day, of course, no other fuse was used, for that would have given inexact time, and the rule had been strictly laid down that should accidents occur there should simply be no signal. The company were invited to return next day, and at least one-half of them did so, but again there was no signal. On this occasion also the galvanic current and "servant" clock at the Castle did their duty, but the little dropping weight which releases the trigger failed to act. The next day a remedy was applied to this fault in the mechanism, and the signal was precisely delivered. The gun at present used is a 12-pounder.

TARGET EXPERIMENTS AT SHOEBURYNESS.

Some interesting experiments have been conducted at Shoeburyness, under the superintendence of the Iron Plate Commission, upon two new kinds of Targets, built up to resemble a portion of an iron-plated frigate's broadside.

One target was sent in to be experimented upon by Mr. Fairbairn. This was about ten feet long by six feet high, and consisted of four plates five inches thick, the upper and lower being each about ten feet, the two in the centre being only five feet each. The peculiarity of this target was that there was no wooden backing to the armour-plating, for the attention of the Commission has lately been much directed to endeavouring to ascertain how far it is possible by a slight increase in the thickness of the plates to do away entirely with the weight and expense of the vertical and horizontal mass of timber beyond them. Another peculiarity was the effort to do away with the acknowledged source of weakness which arises from holes having to be drilled in the plates for the bolts to fasten them to the ship's side. In nearly all cases where plates have been fractured by shot the crack has commenced from one of the rivet holes. There were none of these in Mr. Fairbairn's target. The plates were fastened directly to what in an iron frigate would be its outer skin, which, in the case of the target, was represented by wrought-iron three-quarters of an inch thick. From the inner side of this were rib girders much of the same kind as the iron ribs of a frigate would

be. These were half an inch thick by about 11 inches deep and 18 apart, with stout angle irons fastening them to the outer skin. From inside this skin the rivets were let into the plate like topped screws, penetrating a little more than halfway through the five-inch armour-plate. The iron used in this target was of the very best kind, and the whole of its workmanship was admirable and substantial to the last degree, as the tests showed.

First, a flat-headed steel shot, about 1 lb. in weight, was fired against it to test the quality of the iron. This made only a dent of from a quarter to one-third of an inch in depth. Two of Armstrong's 40-lb. shells, filled with sand, were next discharged point blank at a distance of 100 yards. They also dented the iron to the depth of some three-quarters of an inch, but otherwise seemed to have but little effect, except upon the rivets of the angle iron inside the sheathing, which were apparently somewhat started. Two flat-headed 40-pounder steel shot, fired at the same range, produced more effect. Their indentation was quite an inch and a-half, if not more, and the rivet heads holding the armour-plates were evidently shaken, though apparently they held as firmly as ever.

The 100-pounder Armstrong was next tried at 200 yards, with a shell filled with sand. This broke one of the angle irons of the inner sheathing, made a deep dent, and started some of the smaller rivets, yet on the whole surprisingly little damage was done, and practically the target seemed as strong as ever. A solid 100-pounder shot was then tried, and this struck with a tremendous blow the centre of the mark, the effect of which visibly started the plates and rather curved them outwards at some of their joints. The effect of two shots from a solid 68-pounder at 100 yards shook the armour-plates still more, starting them from the skin to which they were bolted, and denting them through their entire substance considerably.

A 200-lb. shot was then fired at 200 yards' range. This ponderous missile not only made a very deep dent where it struck, but bulged the whole target in, shaking all the plates loose, and breaking some of the screws which held them. Still, however, no plate gave way under these tremendous visitations, nor had any of them been detached. The last shot fired was with a 100-pounder, at 800 yards, and the effect of this was final. By the force of the concussion the upper plate, with one of the centre small ones, was completely detached, and came crashing down, leaving those that still remained in a very shaky and precarious condition. It was, however, considered by all on the ground to have withstood the rude assaults it had received in the most extraordinary manner. The screws held on to the very last, and a great deal longer than any one expected, while the plates, though, of course, much battered and defaced, were not only not broken, but showed no symptoms of becoming so. On the whole, therefore, it was considered that the resistance offered by a target built on this plan had been most satisfactorily proved, and the value of some of its improvements established.

The next experiments were made upon a Target invented by Mr. Roberts. This was the very reverse in principle from Mr. Fairbairn's, inasmuch as the thickness of the iron plates was diminished while the timber backing was increased. Mr. Fairbairn's showed how shot-proof frigates might, with advantage, be made of iron only, while Mr. Roberts's was designed to prove that wooden ships could be as easily rendered shot-proof as if specially built for the purpose. The back of this target was formed of wrought-iron three-eighths of an inch thick. To this were fastened iron T plates, which on a frigate would run along the vessel's side fore and aft. Between these were fitted oak beams nine inches square, which, being all tight caulked, hold the plates firmly in their position, so as to prevent lateral bend, and enable them to resist the *maximum* pressure due to their strength. Over this again comes another layer of beams and T plates, placed vertically, fitted in the same way, and bolted firmly in to the ship's side. Over all this come the armour-plates. Each of these latter are three inches thick and two feet wide, and made in an angular form, something like a wide-shaped letter V. All the joints are placed so as to ensure accuracy of fit, and thus when a ship's side was covered with these plates, the alternate angular projections and recesses would resemble in shape, on a small scale, the ordinary ridge and furrow roofing used in glass buildings. Where the longitudinal joints occur a recess is cut in the plates, into which is fitted an iron rib 6 inches wide and 4½ deep, the outside face of the rib being also angular. These joints ribs are fastened through with 1½-inch bolts, while the V-shaped armour-plates are secured by 9-inch bolts, 18 inches apart. Each armour-plate rises from the side of the ship to an angle of about one foot in height, the face of each angle being also a foot in depth.

On this system Mr. Roberts and Mr. Burn, C.E., contend a ship may be built of the same strength, costing only one-fifth of the money required for a ship constructed wholly of iron, and being only one-third of the latter's weight. The target experimented on at Shoeburyness was built entirely on the principle we have here mentioned, and was on the whole an exceedingly fine piece of workmanship, though it was too small. It was only six feet by four, and consequently, as all the shots were aimed low, they struck almost on the same spots, which wanted the surrounding support a larger target would have naturally afforded. So far the test of strength was taken at a disadvantage to the invention. The first shot fired at it with a 1-lb. flat-headed steel ball to test the iron, struck upon the angular face of one of the armour-plates. Yet, in spite of this, it apparently made as deep a dent as a similar projectile had made in the flat upright plates of Mr. Fairbairn's target.

Two 40-lb. shells, filled with sand, were fired from an Armstrong at 100 yards, but did no perceptible damage. A flat-headed 40-pounder which was next fired struck one of the rib joint pieces we have spoken of between the angles, and broke it. It, however, still remained firm in its place, and a 100-pounder Armstrong shell, at 200 yards, did no apparent damage. Not so, however, with a solid shot at the same range, which came full upon the edge of the angle of the centre plate, inflicting a deep dent, and slightly fracturing through the plate itself.

The next, a solid 68-pounder, hit full upon the same joint rib which had been struck and broken before with a tremendous blow. It split the rib joint at its outer rivet hole, breaking off the end of it entirely. Still, however, the target was quite firm apparently. The next 68-pounder fired struck full upon the extreme lower edge of the mark with such force as to shatter the wooden frame which supported it, and turn the target completely over on its face. It was evident, therefore, that this missile hit with undiminished force, and that apparently striking on the angle of the plate did not, in this case at least, at all tend to make it glance off and so diminish the concussion.—*Abridged from the Times.*

ARTILLERY AND ARMOUR-PLATES.

Of the contributions to the Mechanical Section of the British Association upon these subjects, it is only practicable for us to give a few notes recording the more salient points of the papers.

Dr. Eddy read a "Proposal for a class of gunboats capable of engaging armour-plated ships at sea; accompanied with suggestions for fastening on armour-plates." There was some ground for believing that instead of building with the French, ship for ship, large and costly armour-plated vessels, a better plan would be to construct small, invulnerable gunboats, of great speed. The superior speed which he thought could be given to small vessels would enable two or three such as he contemplated to cripple if not destroy a large ship. In a cupola might be worked a couple of heavy Armstrong guns, moved on a turntable, so as to be easily brought to bear on the enemy in any direction. He would protect them with 4-inch plates, three feet below and four feet above the water-line, putting over the whole an arched iron deck, with a stuffing of some elastic material. A flotilla of such gunboats would be a great protection to the coast, and very serviceable in action.

Captain Blakely described the method of constructing his description of cannon by surrounding cast-iron guns with wrought-iron hoops under *a certain* degree of tension. He understood Sir William *Armstrong was making a* 300-pounder gun, but he (Captain Blakely) *hoped to make a 600*-pounder; they might go to 6000 or even 60,000-*pounders.*

Mr. Fairbairn gave the results of experiments on targets at Shoe-

buryness, and described the effect of shots upon 5-inch plates, with 18 inches of wood backing. Wherever a shot struck it bent the plates, and, the wood being a yielding substance, the plates were indented into it, thus proving very injurious in breaking the bolts by which the plates were fastened. The 120-lb. shots, flying 11,000 feet per second a distance of 800 yards, never actually penetrated the five inches, but made damaging indentations. Cast-iron balls, if they did not penetrate, were smashed to powder. If they could have metal really homogeneous, and build the ships wholly of thick iron plates, without any wood backing, he thought they would be able to resist the power of even a 300-pounder gun.

Mr. Fairbairn stated that one of the results of the experiments made was to convince him that, though we had very good iron in this country, yet he did not think that the quality of the wrought-iron was quite so good as some produced in other countries. The iron itself was good, but it had not that uniformity of texture which was obtained in foreign countries. Our ironmasters, he believed, were bestowing attention on the subject, and in a short space of time would, he believed, be able to produce such plates as would have a fair chance of resisting such artillery as Sir William Armstrong's. It was the intention of the Committee to do everything they could to resist Sir William Armstrong, and he on his part would of course do everything he could to smash them up. In the case of armour-plated ships, it was not only necessary to have plates of sufficient thickness, but to have sufficient resistance behind to resist the deflection caused by the shot. In the *Warrior* and the *Black Prince* wood was used for this purpose. His own opinion was, that wood was entirely unnecessary, and that every part of the vessel above the water-line would be better of iron. Experiments had been made to test the velocity of the shot from the Armstrong gun, and it was found to be about 1100 feet per second. Mr. Fairbairn referred to the necessity of securing toughness and homogeneousness in the plates, and also the desirability of securing a better mode of attachment than the present system of using bolts or screws. They had tried experiments with a target composed of iron bars; but they found that the resistance offered was not nearly so great as by the iron plates. Experiments would be continued, and in a few months the Committee hoped to arrive at a definite result with regard to the proper thickness of the plates, the mode of attachment, and the quality of the iron.

Sir J. D. Hay rose, at the request of the President of the Association, to supplement his remarks on the Experiments at Shoeburyness with some observations of his own. The Committee, he said, in order to ascertain the best quality of material, the best thickness of metal, and the best mode of manufacturing iron plates, invited the leading manufacturers of the country to place before them specimens of iron plates which they considered best adapted for the purposes required. Plates, varying in thickness from ¼ inch to 10 inches were sent in. The Committee found, on making experiments, that the steely description of metal, that was to say, metal which

had been hardened, and went by the names of semi-steel, homogeneous iron, &c., up to a thickness of ¾ in., possessed great resisting powers, but after that thickness, this description of metal was not so well qualified to resist a blow of a projectile as wrought-iron of the best kind. This having been ascertained, another law had been pointed out to them which they were not yet in a position fully to recognise. It was that the resistance of the plating increased with the square of its thickness. Thus, if the resistance of a plate 1 inch in thickness was equal to 1, the resistance of a plate 2 inches in thickness would be 4; 4 inches in thickness, 16; and 6 inches in thickness, 36. Considerable difficulty was felt in fastening the plates upon the sides of the vessels, as it was felt that all holes drilled in them were a source of weakness. Mr. Scott Russell had a plan of fastening the plates. Their great fear was not of a solid missile being driven through the ship's sides, but of the possible materials the shot might contain. They could scarcely hope effectually to exclude cold shot, but they did think it was possible so to construct a ship and so to plate it, that a hollow missile impinging upon its sides would be broken to pieces, and consequently they hoped to be able to exclude all shells, red-hot shot, and shot filled with liquid iron, which were amongst the most terrible weapons of modern warfare. In the course of their experiments they had tried the effect of the shells upon an old brig, the *Hussar*. At the twelfth round the brig was on fire beyond the possibility of extinction. He thought it a misfortune that the stem and stern of the *Warrior* were not better protected—and the steering apparatus was placed in that part of the ship from which the missiles were scarcely excluded at all. He thought it a wise determination on the part of the Admiralty to convert the wooden line-of-battle ships laid down into armour-plated vessels of great size and speed. In the course of the Shoeburyness experiments, they had found that at whatever angle the targets were placed, the fracture made by the Armstrong gun was just as large, though it differed somewhat in shape, according to the angle. He could only account for this fact by supposing that the damage was done by the instantaneous concussion, and not by the shot boring or punching a hole through.

Mr. T. Aston read the closing paper, "On elongated projectiles." He compared Mr. Whitworth's rifled shot with the lead-coated ones of Sir W. Armstrong, and held the former to be superior, since the latter were liable to strip, and also exhausted a portion of the power of the powder in forcing the lead into the rifled grooves. Mr. Whitworth, he said, was the first to use the flat-ended shot, which punched out the iron; and to give a taper to the back part of the ball, which acted like the fine lines at the stern of the ship, in allowing the air to close after it. The latter circumstance, he held, increased the flight of the missile 20 per cent.

Sir W. Armstrong said he did not go so far as Captain Blakely in making great guns. For himself, he thought he should have sufficient difficulty in making a 300-pounder, to say nothing of a 60,000-pounder. He quite agreed with Mr. Fairbairn in the desi-

rability of dispensing with the use of wood in forming the ship. By that they would get rid of the extra weight, and also of the liability of the wood to rotting, and having periodically to pull it to pieces and rebuild. Referring to the observations of Mr. Aston, Sir William replied that he believed his projectile to be more efficient than Mr. Whitworth's. He readily admitted that the flat-ended shot was Mr. Whitworth's invention; but they must not be content with just punching holes through a ship, but must throw a great mass of iron that would crush in her sides.

Mr. Scott Russell said the whole question was summed up by a sailor, who said, "Whatever you do, for God's sake keep out the shell." If only a few holes were made, it would not matter much, but if Sir William Armstrong threw a great mass of iron, and broke in a large hole, that would be very serious. The difficulty of the heavy iron plates was, that it placed a weight of 1500 tons where it added nothing to the strength of the ship, and injured her sailing qualities. What the builders required of the Committee—Mr. Fairbairn and others—was, how they could incorporate the plates so as that they should form armour, and at the same time be part of the ship. As a builder, if eight single inch plates would do as well as one plate five inches thick, he was prepared to satisfy the Committee that it would be enormously better for the ship; but if that would not do, he was willing to give them a 2-inch plate upon six plates of an inch each. He would even go to a 4-inch plate, if they would let him have four single-inch plates for the ship; but Mr. Fairbairn insisted upon a 5-inch plate to go to the bad, and left him but three inch plates to the good. Alluding to Dr. Eddy's paper, he said a small vessel could not carry such heavy armour-plates and yet possess the speed of the larger ship.

Sir E. Belcher also expressed an opinion that small vessels could not carry armour-plates, and pointed to compressed paper as an excellent elastic material for resisting the passage of a ball.

Dr. Robinson said that Lord Rosse suggested the utility of iron plates on a ship long before they were heard of in France, and he had himself seen a rifled barrel which was made two centuries before Mr. Whitworth was born.

Mr. Fairbairn, referring to the observations of Mr. Scott Russell, said the experiments showed that a 2-inch plate was equal in resistance to three or four combined single inch plates, and he believed that the plates could be so fixed as to form part of the ship as well as to answer the purpose of armour. He was of opinion that they would require an iron deck two inches thick to prevent a shell penetrating; and further, that instead of building three-deckers, they would have to be content with one deck, so as to keep the vessels low in the water.

ARTILLERY EXPERIMENTS IN THE UNITED STATES.

CAPTAIN RODMAN has supplied the Government of the United States with some useful facts on the Pressure of Exploded *Gunpowder on Cannons* when discharged. An ingenious instrument,

says the *London Review*, was used to ascertain this pressure. A very strong hollow steel cylinder has working within it a piston about a third of an inch in diameter, one end of which is made flat, and the other is armed with a hard steel point, which is opposite to a copper bar screwed tightly in at the other end. Any force, therefore, which acts on the flat end of the steel piston, tends to drive the steel point into the copper bar. A hole of the same diameter as the steel piston is then drilled through the wall of the cannon to the bore, and the outer portion of this hole is enlarged to receive the steel cylinder, which is then tightly screwed into it, the flat end of the piston being thus brought opposite the small hole leading to the bore of the cannon. The gun is then loaded with a charge, the pressure of which it is desired to ascertain. The gases arising from the combustion of the powder press against the inner end of the piston and force it upwards, driving the steel point into the copper bar to a depth depending upon the amount of the pressure. The cylinder is then unscrewed from the gun, and the copper bar and steel points are placed under a massive press, and the force required to produce an indentation equal to that produced by the gas is accurately measured. Captain Rodman says that a difference of 250 lbs. in 30,000 lbs. is plainly perceptible, so that the indications of this instrument may be safely regarded as approximating to within 1000 lbs. of the true amount, even for the greatest pressures exerted, and much nearer for the smaller ones.

The following are some of the most interesting results obtained:—In a 42-pounder gun, 14 lbs. of powder, with two shot, and one wad, gave a pressure at the bottom of the bore of 55,662 lbs. per square inch; with double the amount of powder, the pressure was raised to 64,510 lbs. In another series of experiments, when the projectile was of a constant weight, and the charges were increased successively, 3 lbs. of powder gave a pressure per square inch of 11,319 lbs.; 6 lbs. of powder gave a pressure of 18,811 lbs.; 9 lbs. of powder a pressure of 28,972 lbs.; and 12 lbs. of powder a pressure of 38,961 lbs. A similar rise of pressure was observed when the charge of powder was kept the same in all experiments—viz., at 5 lbs.; but the projectile was increased in weight. Thus a 40-lb. ball produced a pressure of 17,563 lbs. per square inch; one of 60 lbs. a pressure of 34,966 lbs.; one of 80 lbs. a pressure of 38,462 lbs.; and one of 85 lbs. a pressure of 41,120 lbs.

Guns of different calibres were also experimented upon, and it was found that a very marked increase in pressure of gas took place as the diameter of bore increased; the cause of this is believed to be mainly due to the greater heat developed by the combustion of the larger mass of powder in the large than in the smaller calibre; and perhaps also to the different products of combustion formed under this increased temperature and pressure, and partly to the greater cooling surface in proportion to the weight of charge in the smaller than in the larger calibre. By boring holes in guns at different distances along the side of the bore, the variations in pressure behind the shot as it traversed the length of the tube were well

shown. The results of this series of trials are very instructive; our space will only allow us to quote one example. The bore of the gun was 11 inches diameter, this was charged with 15½ lbs. of powder and a shot weighing 186 lbs. At the bottom of the bore the pressure on firing was 86,750 lbs. per square inch; at 14 inches from the hollow it was 29,300; at 28 inches it was 27,800; at 42 inches it was 22,420; at 56 inches it was 28,400; at 70 inches it was 33,850; and at 84 inches (close to the muzzle) it was 25,050. A point worthy of note in this series is that the indications of pressure are greater at 56 inches, 70 inches, and 84 inches, than they are at 42 inches.

One very remarkable point elicited by these experiments is the enormous pressure which cast-iron guns are able to bear without bursting. The highest pressure observed in a cannon was 100,000 lbs. (upwards of 24 tons) to the square inch; but this was greatly exceeded in a shell. A very strong shell was cast; the exterior diameter being 12 inches, and the interior a little less than 4, with an orifice only one-tenth of an inch in diameter, this in fine being the only outlet for the gas. The cavity was filled with powder, which was fired, when the instrument indicated the enormous pressure of 185,000 lbs. (nearly 45 tons) to the square inch.—*Mechanics' Magazine.*

AMERICAN STEAM GUN.

A CORRESPONDENT who has seen the Steam Gun at Baltimore furnishes the following description of it:—"It is on four wheels; the boiler is like that of an ordinary steam fire-engine, the cylinder being upright. There is but one barrel, which is of steel, on a pivot, and otherwise is like an ordinary musket barrel. It is fed or loaded through a hopper, entering the barrel directly over the pivot. The barrel has a rotary motion, and performs the circumference by machinery attached, at the rate of about 1600 times a minute. The balls are let into the barrel through a valve at will, and every time the barrel comes round to a certain point, another valve, self-operating, lets out a ball, which is propelled solely by the velocity of the barrel in revolving. It will discharge a two-ounce ball 300 times a minute. The range is accurate up and down, but the balls are liable to hit wide of the mark on one side or the other. The barrel revolves inside of a drum made of boiler-iron, between five and six feet in circumference, with an opening where the balls are discharged. Its range is not over 100 yards at best, and the gun can be worked so as to discharge in any direction. The whole thing weighs 6700 pounds, and is about the size of a steam fire-engine. It is the opinion of our informant that the gun does not warrant the expectations of the inventor."—*New York Paper.* (This is another confirmation of the opinion of the great Duke of Wellington as to the inefficiency of the steam gun as an instrument of war.)

"THE FLEET OF THE FUTURE."

MR. SCOTT RUSSELL has published an able pamphlet* upon this important question, of which we find in the *Mechanics' Magazine* the following comprehensive outline. The first question for discussion is the comparative value of iron and wooden ships-of-war. In favour of the latter, we had Sir Howard Douglas, whose opinion was "that ships formed wholly, or nearly so, of iron, are utterly unfit for all the purposes and contingencies of war, whether as fighting ships or as transports for troops." In opposition to this opinion Mr. J. Scott Russell endeavours, and we think successfully, to establish:—

"1. That iron steam-ships-of-war may be built as strong as wooden ships of greater weight, and stronger than wooden ships of equal weight.
"2. That iron ships of equal strength can go on less draught of water than wooden ships.
"3. That iron ships can carry much heavier weights than wooden ships.
"4. That they are more durable.
"5. That they are safer against the sea.
"6. That they are safer against fire.
"7. That they are much safer against explosive shells.
"8. That they are much safer against red-hot shot.
"9. That they are much safer against molten metal.
"10. That they can be made impregnable even against solid shot."

As Sir H. Douglas had attacked the construction and sailing qualities of the *Great Eastern*, his opponent first disproves his assertions and predictions regarding her, and then states the facts regarding iron war-ships which have been ascertained by actual experiment. Experience has proved, first, that "when the thickness of a vessel's side is not more than half an inch, shots fired obliquely have glanced off the iron vessel which would have penetrated a wooden ship; second, that shots fired directly have passed through both sides of the ship, doing less damage to the ship directly and less damage by splinters than would have been the case in timber ships; third, that the shot holes have been as easily stopped, and more expeditiously and less expensively repaired than in wooden ships; fourth, that their plates of wrought-iron, even five-eighths of an inch, are proof against shells; that plates two inches thick are impenetrable, even to the pieces and fragments of shells; that iron plates four inches and a half thick are nearly impenetrable to shot fired from the heaviest nature of guns; and, finally, that plates six inches thick are practically impenetrable."

The indecision and incompetence of our Admiralty, and the prejudices of sailors, have delayed the use of iron for ships-of-war, and this in the face of experiments, and our experience during the war with Russia. We cannot, therefore, expect that even Mr. Scott Russell will succeed immediately in convincing seamen of the superiority of iron over wood for steam-ships of war. But the facts in favour of this opinion are indisputable, and few outside of the navy will dispute the substantial accuracy of his conclusion, "that the impene-

* *The Fleet of the Future: Iron or Wood?* Containing a reply to some conclusions of General Sir Howard Douglas, Bart., G.C.B., F.R.S., &c., in favour of wooden walls. By J. Scott Russell, Esq., F.R.S., &c. London: Longman, Green, Longman, and Roberts.

trability of iron plates from three-quarters of an inch which keeps out all shells, to four, six, and eight inches which practically keeps out all shot, is the fundamental fact on which the iron fleet of England has yet to be constructed."

England's future fleet must, therefore, be of iron, and consist of the following classes. First, iron steam-ships of the line. These, if built to carry 100 guns, must be each of 10,000 tons burden, have engines of 2500 horse-power, carry fuel for 5000 miles, and will cost us, fully equipped and armed, 750,000*l*. The second-class will be iron steam-frigates. These, if built to carry 50 guns, must be each of 7000 tons burden, which is a little larger than the *Warrior*, of 6000 tons burden, have a speed of 15 knots, fuel for 5000 miles, and will cost, when completed and armed, 500,000*l*. Such a vessel would be cheaper per gun than the *Warrior*. The third class will be iron steam-corvettes. These must have the same speed as the others, and coal for the same distance, but will carry 20 guns, sail 15 knots, be of 5000 tons burden, and cost 300,000*l*. These three classes our author designs to act together at sea, in all weathers, and in any portion of Her Majesty's dominions. These three classes constitute a separate division. They are all to be impregnable, and an overmatch, beyond all comparison, for any wooden ship of the same number of guns now in existence.

The three remaining classes of vessels in the future iron fleet must have a high speed equal to that of the first three classes, but only partial protection. The fourth class, therefore, will consist of iron steam-clippers, of 2500 tons burden, carrying 10 guns, having 4 guns and her boilers, machinery, and magazines perfectly protected; her speed will be 15 knots, her cost 160,000*l*. The fifth class should be like the existing steam-sloops of the navy, except that they should be of iron, and faster. They should be 2000 tons burden, carry 10 guns, and cost 120,000*l*. The sixth class, built for speed alone, should also carry 10 guns, but should perform 16 to 17 knots. The cost of each would be 100,000*l*.

In addition to these classes, Mr. Scott Russell proposes iron gun-boat flotillas. These also are ranked in different classes; first, gun-boats of 120 tons burden, of 30 horse-power, carrying 25 men, with a speed of about 8 knots, and drawing between 4 and 6 feet of water. Fifty of these should be built every year until we have enough. Second, paddle-wheel despatch-boats, supplementary to the gun-boat flotilla, each of 100 horse-power, 300 tons burden, carrying two guns, and having a speed of 10 knots. Third, screw vessels of about 400 tons, also carrying 2 guns, drawing 8 feet of water, and able to steam 10 knots. Fourth, gun vessels like the *Recruit* and the *Weser*, only larger and faster, and like them armed with 4 large guns, also to be capable of being navigated, like class second, either end foremost, and to be partially protected.

The total cost of a Channel fleet of iron steam-ships, consisting of 10 ships of the line, 10 frigates, and 10 of the corvette class, would be 15,500,000*l*. An auxiliary fleet, consisting of 10 steam-clippers, 10 steam-sloops, and 10 despatch boats would cost us 3,700,000*l*.

With such a fleet we would require only one-fourth of our present number of seamen. 23,500 men would do the work of the 85,500 now employed in our fleet and coast-guard service, and would certainly be an overmatch for all the navies in the world put together. With such a fleet, our ships would be easily manned. 25,000 sailors in it will be as effective as 100,000 in the old. Its construction would raise the character and position of all classes of men connected with it, and especially favour the increase of knowledge and skill among our naval officers and naval architects. An iron fleet will, undoubtedly, be much cheaper to maintain than a wooden one. The annual maintenance of the proposed fleet would be only 200,000*l.*, for an iron ship, if well cared for, never decays. The current annual cost of our fleet afloat is now about 5,000,000*l.*; while another 5,000,000*l.* are expended annually in our dock-yard establishments. If, therefore, a new iron fleet should cost us 20,000,000*l.*, it would be much cheaper than the vaunted wooden walls which we are always reconstructing, overhauling, cutting down, lengthening, converting, and yet, like Dutch clocks, are always out of repair.

Such is the scheme of national defence proposed by one of the most celebrated of living architects. Its completeness, the name of its author, and the admirable clearness and force with which it is stated, must tell upon the naval policy of all great nations.

EXPERIMENTS UPON THE "WARRIOR."

SOME Target Experiments have been made at Shoeburyness, in the presence of the Lords of the Admiralty, in order to test the strength of the *Warrior*. The target was a perfect section of the *Warrior's* broadside, twenty feet long and ten high, made by the Thames Iron Company, of exactly the same materials as the *Warrior* itself. This was erected at two hundred yards' distance from a battery of six guns—two solid 68-pounders, three of Armstrong's 100-pounders, and one 120-pounder shunt gun. The chief curiosity was to see how the teak backing would support the plates, and, above all, how the rivets in the ribs would resist the tremendous concussion. No one, however, was prepared for the astounding success of the result that did ensue, and which showed itself at the close of the experiments, during which the target was subjected to every conceivable ordeal of artillery practice, yet survived comparatively uninjured, and practically as invulnerable as ever. The guns were fired in volleys of threes, and fours, and sixes simultaneously. Their shot were concentrated upon white spots painted on what were supposed to be the parts most likely to yield. On these the fire of the most tremendous missiles—100-pounders, 120-pounders, and even 200-pounder bolts—were directed, with a force and weight that seemed irresistible; but in vain. The shot flew off in ragged splinters, hissing through the air, the iron plates became almost red-hot under the tremendous strokes, and the whole target rang like a huge gong, but nothing more. As a rule, the 68-pounders left their mark in massive dents more deeply than the 100-pounder Armstrongs, but the live percus-

sion shell of either did little more than discolour the plates with the smoke of their impotent explosions. A grand final salvo was given with all the six guns, trained three on each of the already battered spots. As the guns were loaded each with 16 lb. of powder, this volley, in fact, was equal to a 600-lb. shot fired at the target with 100 lb. of powder. The effect of this tremendous trial was to make a gap on one side of the target about fifteen inches long, and five deep, driving the iron, in fact, almost into the teak. Some bolts of the plates were also loosened, and the plates themselves began to crack. Yet, strange to say, even under this the strong teak backing was still undisturbed, and not even the paint on the rivets had started. In fact, as representing the side of a ship, she would still have been perfectly water-tight and uninjured. The tonguing and grooving by which the edges of the plates are dovetailed into each other had given way, as we always maintained it would, and some of the plates themselves had started outwards as much as an inch and a half. But the target, as a target, was as good as ever. There is only one possible condition in which the *Warrior* could be placed to be exposed to a concentrated fire as severe as that to which her section was subjected at Shoeburyness, and that would be if she stranded within two hundred yards of the guns of a powerful fortress. Even then, in such a last extremity, we are very much inclined to believe the *Warrior* would be quite as formidable to the fort as the fort to her.

The practical result of this grand experiment has been to show that nothing is gained by backing up the armour-plates with such a tremendous thickness of teak as twenty inches. It is found that practically ten inches will do as well as twenty, and that the saving thus effected in the reduction of weight will allow another inch thickness of iron to be used in the plates themselves. Thus the "improved *Warriors*" now building, instead of 4½ inches of armour and 20 inches of teak, are to have 10 inches of teak and 5½ of iron—an addition to the metal covering which is really unnecessary, as [they are already invulnerable, in the most perfect and literal sense of the term, to all the efforts of artillery.—*Abridged from the Times.*

TRIAL OF THE "WARRIOR."

THIS ship, the first afloat of England's iron-clad navy, made her official trial of speed at the measured mile in Stokes Bay, near Portsmouth, on October 17, in charge of Captain Broadhead, commanding the steam reserve at the port, and under the supervision of Mr. Lloyd, engineer-in-chief to the Admiralty; Messrs. Murray and Miller, heads of the engineering department of the dockyard; and Mr. Eames, acting inspector afloat. Messrs. Matthew and Holliday represented the builders of the machinery, Messrs. Penn and Sons. Sir John Pakington was present at the trial of the ship, for the construction of which he had given the order when in office, since which time he has always displayed the deepest interest in her progress up to her triumphant success of Oct. 17, a success

unparalleled in the history of steamships of war as regards their rate of speed at the measured mile. The ship's funnels have been each lengthened 6 feet to improve the draught of her furnaces, which, during the present trial, was found to answer most effectually. By temporary up and downcast airshafts, on plans suggested by Captain Cochrane, the ventilation of the engine-room and stokeholes had also been improved to a great extent, on an average in the latter to as much as 30 degrees less heat, and by the results of these temporary experiments it is anticipated that they may eventually be rendered as cool as those of any other steamship of the navy. A great deal remains to be done to remedy this defect at present.

The ship got her anchor and turned ahead from her moorings at Spithead at 9·30 a.m., and first steamed out towards the Nab Light vessel. Between the two light-ships, the ship's head was turned round and laid for the trial ground in Stokes Bay, through which two runs were made before fairly entering on the mile, owing to the boilers partially priming. The first run was entered upon at 58 min. 22 sec. past 10, the engines at the time making 55 revolutions. The distance was run, with the tide, in 3 min. 38 sec., which gave the ship a speed of 16·514 knots. On the second mile the revolutions of the engines were 54; the time 4 min. 57 sec., against the tide, and the speed in knots 12·121. The revolutions of the engines on the third run were 54¼, time of the run 3 min. 38 sec., the same as the first run, and speed also the same, 16·514 knots. The fourth run the engines made 53¼ revolutions, the time in which the run was made being 4 min. 50 sec., and the speed of the ship 12·413 knots. On the fifth run the revolutions of the engines again reached their *maximum* point, 55, the time being 3 min. 45 sec., and the speed of the ship 16·142 knots. In the sixth and concluding run, the engines made 53¼ revolutions, the time being 4 min. 47 sec., and the ship's speed 12·543 knots. These runs give the following results:—First mean speeds in knots,—14·338, 14·338, 14·463, 14·278, 14·343. Second mean speeds,—14·338, 14·400, 14·370, 14·310. True mean speed—that is, the actual speed attained by the ship as shown by the results of her six miles' trial—14·354 knots.

The ship had 760 tons of Nixon's navigation coal on board, of the same quality as that used on board Her Majesty's yacht *Victoria and Albert*, and four months' provisions under hatches, together with all her sea stores,—drawing 26 ft. 5 in. of water aft, and 25 ft. 6 in. forward. The average pressure of steam was 22 lb., the vacuum in the condensers being 25½ lb. The propeller was an improved Griffiths's, of 24 ft. 6 in. diameter, and 30 ft. pitch. The temperature in the engine-room ranged from 82 deg. on the platform to 92 deg. at the back of the cylinders. In the foreward stokehole it ranged from 94 deg. to 109 deg., and in the after stokehole from 82 deg. to 129 deg. The indicated horse-power of the engines was 5560·8. The engines worked in a most satisfactory manner. There was a total absence of vibration in the ship, the only feeling approaching to that great destroyer of our steamships of war being the mere beat of the screw in its revolutions through the water. As an illustration of this, the *Warrior* could fire her 100-pounder guns, forward and aft, when at full speed, with a certainty of hitting the object fired at if within reasonable distance, whereas a wooden ship would fire the same guns with a certainty of *not* hitting the object. *In fact, it would be impossible* to say how wide the shot—from, say, *the Duncan's 100*-*pounder*—would go from the mark fired at when *the ship was under full* steaming power. This is, of course, owing

to the great amount of vibration always existing at the extreme ends of wooden steamships of war, a vibratory movement which the *Warrior*, most fortunately, does not possess. The speed attained by the *Warrior* places her at the head of the British navy in that particular. Previously the *Mersey* bore the honours of being the fastest of Her Majesty's ships, but these have now been wrested from her by her iron sister. The *Mersey* on her trial attained a speed of 13·290 knots when in sea trim, with a 5308 tons displacement, an indicated horse-power of engines of 4044·5, and a nominal horse-power of 1000. Comparing with this the 8800 tons displacement of the *Warrior*, with only an additional 250-horse power to assist to drive it through the water, the results of the *Warrior's* trial cannot be looked upon otherwise than as a great and unexampled success, both in hull and machinery, and full of promise for a successful future for our iron ships. The real trial of the *Warrior* will, however, be on her sea-going trial-trip. The coals used are from the Aberdare pits, Nixon's navigation coal, from the upper four-foot seam, and which, as we have already stated, have been used on board Her Majesty's yacht, and very highly reported upon by Captain Denman. From experiments carried out in Portsmouth yard, it has been found that this description of coal possesses 20 per cent. greater power than the ordinary Welsh coal.—*Abridged from the Times*.—The *Warrior* was described in the *Year-Book of Facts*, 1860, pp. 11—13; and *Year-Book*, 1861, pp. 33—36.

LAUNCH OF THE IRON-CASED FRIGATE "RESISTANCE."

THIS vessel was launched from Messrs. Westwood and Baillie's yard, near Millwall, on the 11th of April.

The chief dimensions of the *Resistance* are—length extreme, 292 feet; breadth, 54 feet; depth from spar deck, 38½ feet; and tonnage, by builders' measurement, 3668. She was designed and built with a view to being used as a "ram," and therefore, instead of having a concealed, obtuse beak, like the *Warrior* and *Black Prince*, the whole outline of her bows exactly resembles the curved line formed by a swan's neck and breast. Thus, the projection of the breast is placed below the water-line, and would strike the enemy below the water-line also. It is this projecting beak and exceedingly retreating bows which give the whole vessel so clumsy and unwieldy an appearance in the water. As a specimen of iron-work manufacture she is perfect: neither the *Black Prince* nor the *Warrior* surpassing her in the care and strength with which the whole frame is put together. Like those vessels, she has no external keel, but an inner kind of girder, which acts as a kelson; and which, from stem to stern, is formed of immense strength. To this are bolted the massive ribs, which are made in joints, with an angle or ledge on the outer side, on which the armour-plates, with their teak lining, 22 inches thick, are to rest. The armour only extends a length of 144 feet of her broadside, and thus only 14 guns out of the 32 she is to carry are under cover. In proportion to size and tonnage hee armament is greater than the *Warrior's*, though, in proportion also,

a smaller number are sheltered by the armour. The orlop deck is of wood, but the main and upper decks are of iron; and all the decks are carried on wrought-iron beams of the most powerful description, to which both decks and ribs are riveted together with as much firmness as if the whole were one piece of wrought-iron. The armour-plates are of the same size and excellence as those which cover the frigates already launched; they are about 16 feet long by 4 broad, and 4½ inches thick. Behind these come the beams of teak, while the bolts which secure the plates themselves are countersunk outside, so as to have their heads level with the surface of the plate. On both sides the armour is continued to 5 feet below the water-line. The stem and stern, which are unprotected by armour, are crossed and recrossed in every direction with watertight compartments of the most solid kind. Those which cut off the stem and stern from the armour-coated portions in the centre are faced with plates to 5 feet below the water-line, backed up with iron ribs and 22 inches of teak—exactly similar in arrangement to the strongest part of the broadside. The bows, as the place where the whole force of the blow must be received when the *Resistance* is used as a stream-ram, are strengthened inside with a perfect network of iron of the most massive kind. Here no less than eight wrought-iron decks stretch back from this portion to the armour-plates, in addition to other supports, such as cross-bracings and bulkheads, almost innumerable.

Throughout the entire length of the armour-coated portion run two wrought-iron bulkheads, one inside the armour on each side. These are termed wings, and serve as main passages of communication. Inside these wings are the coal bunkers, inside these again are the water tanks, and within all the magazines. The engines of the *Resistance* are to be of 600-horse power, and with these it is anticipated that a speed of even 15 knots an hour will be obtained. This certainly appears a rather sanguine estimate for a ship of 600-horse power, of such immense weight, and, above all, of such unusually full and heavy bows. If her form is in fault, however, the Admiralty are to blame, for they supplied the model. In point of workmanship, all that could be done has been effected, and a better built ship was never sent afloat. It was a very quick and easy launch, and in less than a minute after the first movement commenced, the *Resistance* was afloat in the middle of the steam, turning lightly to her moorings. She looked even less sightly in the water than out of it. Her draught appeared to be about 13 or 14 feet, and from her look thus it seemed as if, when brought down to her full load-water-line, her portsills and hawse pipeholes would be uncomfortably near the water.—*Abridged from the Times.*

IRON-CASED SHIPS OF THE BRITISH ADMIRALTY.

Mr. E. J. Reed has read to the British Association a paper on this subject, in which he enumerated and described the vessels at present constructed; and stated that the construction of six other vessels had been determined upon, the contracts for three of this

number having already been issued. It was important to observe that, notwithstanding the long delay on the part of the Admiralty before they commenced the construction of vessels of this class, the determination of Parliament to have a fleet of Iron-cased Ships had even now overtaken the Admiralty, and no experiments on a large scale had yet taken place. The great expense it would be necessary to incur to conduct target experiments on a large scale had probably much to do with the delay. A committee of eminent shipbuilders had lately estimated that the cost of a target large enough to test half-a-dozen modes of construction would be no less than 45,000*l.*, and another 45,000*l.* would have to be expended in the construction of a floating hull on which to place the target. The three new ships in course of construction would be twenty feet longer than the *Warrior*, fifteen inches broader, 582 tons additional burthen, and 1245 tons additional displacement; and as the displacement was the actual measure of the ship's size, they would thus be more than 1000 tons larger than the *Warrior*. As the engines of the new vessels were only to be of the same power, their speed would probably be much less than that of the *Warrior*. This diminished speed was one of the penalties we must pay for clothing both extremities of the vessel with iron plates. Another penalty would probably be a great tendency to chop and plunge in a sea-way. The cost of these new vessels would exceed the cost of those of the *Warrior* class by 20,000*l.* or 30,000*l.* They would certainly be noble specimens of war ships. A vessel built throughout of iron 400 feet long and nearly 60 feet broad, enveloped from end to end in armour impervious to all shell and to nearly all shot, furnished with the most powerful ordnance, with ports nine feet six inches above the water-line, steaming at a rate of twelve or thirteen knots an hour, would indeed prove a most formidable engine of destruction. If the present intentions of the Admiralty were carried out, we should have six of such vessels added to the navy in the next year or two. In vessels of this kind all beautifying devices must be dispensed with. Their stems were to be upright, or nearly so, without that forward reach, the "knee of the head," which added so much to the beauty of the present vessels. Their sterns would also be upright, and as devoid of adornment as the bows. It should also be stated, as a distinguishing mark of these six ships, that their thick plate would not be extended to the bow at the upper part, but would stop at the junction with the transverse plated bulkhead, some little distance from the stem, and this bulkhead would rise to a sufficient height to prevent the spar deck from being raked by shot. They would be armed with fifty 100-pounder Armstrong guns, forty on the main deck and ten on the upper.

It was not yet determined, he believed, whether these new ships were to be backed up with teak, as in the previous ships, or whether the plates should be 6½ inches thick without wood. This would not be decided upon until after the termination of the experiments with the large targets suggested by the President and others. All that was yet definitely determined was, that whether the armour be made of iron alone, or of iron and wood, its weight should be equal

to iron plates 6½ inches thick. He now came to notice a very different class of vessels, of which the hull was mainly timber with armour plated upon it. The *Royal Alfred*, *Royal Oak*, *Caledonia*, *Ocean*, and *Triumph* were all vessels of this class. Their length was to be 272 feet, breadth 58 feet, and displacement, 6839 tons. Each would be fitted with engines of 1000 hors-epower. They were formed with timber originally designed for wooden line-of-battle ships, but had been lengthened eighteen feet. The whole of these ships, it was believed, as well as the iron-plated ships, would match *La Gloire* in speed, provided they were fitted with the engines at first proposed. It was necessary to make this proviso, because there was a probability of smaller engines being put into some of them.

He could not pretend to compare the French and English ships with each other in detail; but he might mention that a friend of his, who had just returned from France, had furnished him with the dimensions of the *Solferino*, one of the largest of the French iron-cased ships, as follows:—Length 282 feet, breadth 54 feet, draught of water 26 feet, burthen 6820 tons. The vessel will be plated with 4¾-inch plates, right fore and aft at the water-line, and over two decks amidships. With reference to the cost of iron-plated vessels, Mr. Reed said that, assuming the average cost of the ships to be 50*l*. per ton, and the engines 60*l*. per horse-power, then the eighteen ships which we were now building would cost about 4,700,000*l*., and their engines above 1,150,000*l*.—together nearly 6,000,000*l*. sterling; and when masted, rigged, and fully equipped, 8,000,000*l*. would have been expended upon them.

He referred, in conclusion, to the extensive dock changes which this revolution in shipbuilding rendered necessary, and urged the serious importance of at once supplying increased dock accommodation in the south of England for these ships. He argued that whether in peace or in war such accommodation would be required; that it would be in the highest degree perilous longer to defer the establishment of colossal docks. At present we had no docks fitted in all respects to receive such ships, whereas the French had many. Mr. Reed contrasted the English and French docks; and stated that it had been proposed to increase the French works by the establishment of an immense steam arsenal, protected by a series of impregnable fortresses at Lezardrieux.

IRON-CLAD SHIPS AND PROJECTILES.

MR. LYNALL THOMAS has read at the Royal United Service Institution a paper on the all-absorbing question of Iron-clad Ships and Projectiles. The object of the author is to introduce a method for preventing the penetration of shot and shell into the sides of a ship. The solid iron plate on a coating of timber he considers to be one of the worst plans that can be conceived. The whole force of the blow comes at once upon the plate, and its effect is felt instantaneously through the whole thickness of the plate. An immense thickness of metal is therefore required; consequently, an enormous weight and strain upon the sides of the vessel; the joint effects of

which make the remedy almost as bad as the disease. The wooden back, in his opinion, favours the penetration of shot through the iron.

Of the several methods for preventing penetration he dealt with the three following:—First, by constructing the sides entirely of iron, thus opposing plates of solid metal to the impact of the projectile. Secondly, by sloping the sides in such a manner as to deflect the projectile. Thirdly, by covering the sides with some substance which shall receive the first impact of the projectile, and disperse the force before complete penetration can take place. The objection to the first method is that, with the continual improvements in the means of attack, so great a thickness of metal would be required that no ship could carry it without detriment to her sea-going qualities. The same objection holds good in principle to the second method, for though a less thickness of metal might be found sufficient, yet vessels thus constructed must of necessity lie so low in the water, that in engaging land batteries, or vessels much higher than themselves, the shot would strike the sides at right angles, while in a rolling sea the sloping sides would occasionally become vertical, and be then exposed to the full force of a shot just the same as an ordinary vessel. Experiments, moreover, with elongated shot have demonstrated that the thickness of metal cannot safely be diminished.

The third method, that of dispersing the force of the shot before it can penetrate the sides, appears to Mr. Lynall Thomas to secure the greatest efficiency, convenience, and economy. The method which he submitted, he believes, will be found well calculated to attain the desired end. He claims it as a new idea, and as the joint invention of Colonel De Bathe and himself. The principle upon which the design proceeds is to protect an iron vessel with iron armour. The armour has received the name of "the louvre plate," from its resemblance to the louvre board or jalousie blind. The arrangement and disposition of the metal may be thus described:—Upon the true sides of the vessel, which are, say one inch and a half or two inches in thickness of iron, the louvre plates are placed one above the other, having an interstice between each which may be filled with an elastic substance, such as New Zealand flax, junk, &c. In the diagram exhibited the plates were from one and three-quarters to two inches thick, and the interstices from three-quarters to an inch. These louvre plates are fixed by means of stout screws to the sides of the vessel, which present a kind of zig-zag outline, in order to receive the edge of the plates at right angles. The whole of the exterior is then coated with small thin metal plates, which besides giving an unbroken surface externally, tends to fix the louvre plating more firmly in its place, and to afford additional protection to the sides of the vessel. As compared with wooden vessels plated with iron, Mr. Thomas claims for his plan a considerable saving in weight, amounting in some instances to one-fourth less. "It will be perceived (he says) that by this peculiar disposition of the metal the force of a shot's impact is felt, not in the direction of a shot's flight, as in the case of a solid plate, but at a point above it, and therefore the effect upon the hinder plate is enormously reduced. Very little solid resistance

is offered to the first impact of the shot; but the quality of elasticity so largely possessed by iron is made subservient to resisting the effect of the impact in a very high degree."

Among other advantages which the arrangement possesses, one of the most important is, the ease with which any damage may be repaired, so much so that a vessel may even carry spare plates and repair her damages at sea. Again, the effect caused by a shot striking is confined to a smaller space than when a large solid plate is struck, more especially when the plates are not penetrated. An elongated shot, from the unequal resistance which it would encounter on its fore-end in striking plates of this kind, would have its penetrating power very much lessened, in fact, more than when striking a surface offering uniform resistance.

Admitting, however, the impossibility of entirely preventing the sides of a vessel being penetrated by solid shot, there being a limit to the weight of iron which a ship can carry, while the limit to the weight and force of projectiles has not been reached, he proceeds in his paper to consider the best course to be pursued in order to enable ships to resist penetration by elongated shells; and then passes on to the question of projectiles. In close action with a gun of a given weight, he recommends a heavy charge of powder and a light projectile, because it is the propelling force which drives the shot through, and at short distances great accuracy is not of so much consequence. To increase the weight of projectiles and diminish the charge of powder is to him an erroneous idea; and he quotes Sir Howard Douglas to show that no additional weight in the projectile will increase the effect of its impact.

Mr. Thomas gives the results of experiments with a rifle-gun constructed upon a principle of his own, from which a charge of 21 lbs. of powder can be fired with projectiles of any weight, from 120 lbs. to 180 lbs. and upwards. On one occasion nine rounds were fired with a charge of 28 lbs. of powder and with projectiles of 175 lbs. in weight; three of the rounds at an elevation of 37½°. The range attained was nearly six miles, and the penetration into the earth totally prevented the recovery of the shot. The time of flight was from 37 to 40 seconds. No iron plate which has yet been placed on a ship's side could resist the impact of a shot from this gun at any distance within 2000 yards; for, according to Sir Howard Douglas' method of calculation, the force at any point within that distance would be equal to that of a 68-lb. shot when it first leaves the muzzle of the gun. He thinks that the *Warrior*, and ships of her class, armed with twenty-four of these guns, would prove more formidable and efficient than with the thirty-six Armstrong 100-pounders which it is proposed to put into her. A powerful armament and great speed are matters of the highest importance, and not to be lightly sacrificed. An iron-cased vessel wanting these qualities would present a mere inert target to a more active and better-armed opponent, and her certain capture and destruction would be simply a question of time. A ship of war, he adds, is commissioned to "burn, sink, and *destroy*," not simply to save herself from being *burnt, sunk, or destroyed.—Mechanics' Magazine.*

IRON-CASED SHIPS.

At the Institution of Naval Architects a communication has been read from General Sir Howard Douglas, on the subject of iron ships and Iron-cased Ships, in which remarks he had taken care, he said, not to confound the two questions together. He considered the *Warrior* and the other vessels now being built of timber combined with iron to belong to the category of iron-cased ships; for although the only timber used in the formation of the *Warrior* consisted of two layers of wood, 8 and 10 inches thick respectively, placed behind the plates; yet, but for the timber with which the plates were backed up, the sides of the ship would not be shot-proof, nor could the plates be firmly fixed. He would not follow Mr. Scott Russell in the plunge he had taken to dive into the future of the British navy; but to the question put in that gentleman's pamphlet —"Iron and Wood; which shall it be?" he (Sir H. Douglas) confidently replied—of neither singly, but by a combination of both, to constitute that new description of vessels for special purposes in which the French had taken the lead, but which lead we must take out of their hands by constructing iron-cased ships which, like theirs, should be formed of timber; that was on wooden bottoms having iron-cased sides, the number and strength of these vessels to be extended according to circumstances. With respect to ships formed wholly of iron, he adhered firmly to the opinion that they were utterly unfit for any of the purposes of war. The *Great Eastern* belonged to that category, and no one could assert that a vessel that might be perforated through and through by 68-pounder solid shot was fit for such purposes. Being formed of plates proof against shells, no shells would be fired at her, but solid shot would do the work much more effectually. No real test of the resistance of the iron-cased ships to shot, nor of ships formed of thin plates of iron, would be made till trial in a state of war; and then the very existence of the country would be at stake on a theory—a speculative experiment, untried in war. It had been said in the *Times* that if the *Warrior* were successful we might bid adieu to timber ships; but the reverse would be the case. Her success would bid adieu to ships formed of thin plates of iron; because, if those ships were not made shot-proof by their thin skins being covered with massive layers of timber, and these in turn covered with 4½-inch iron plates, they would not be fit for war purposes; and, if so covered, would be unfit for commercial purposes in war, having their tonnage either wholly or greatly absorbed, according to their size, by the weight put upon them.—*Mechanics' Magazine.*

Mr. Fairbairn, in his new *Treatise on Iron, its History, &c.,* says:—"The construction of the *Gloire* with armour-plates has, however, settled the question of *wood* versus *iron;* and there no longer exists a doubt as to the superior advantages and impregnable character of the iron ship. The *Warrior*, *Black Prince*, and other vessels of a similar description,* are striking examples of the superiority of the

* Our first attempts at iron ships in our brief but vigorous competition with *the French, resulted in the Warrior and the Black Prince*, "two of the finest, fastest,

iron-cased ship ; and although far from perfect, they are nevertheless of a class that must eventually supersede our wooden navy.

"In my opinion, the whole navy of Great Britain must be remodelled and rebuilt of iron ; and no administration in this country should venture to place another wooden vessel on the stocks. I further believe that it is not only necessary to provide an iron armour, but that the whole structure should be composed of iron, and sheathed with thick plated fenders from the upper deck down to a depth sufficient to protect the ship below the water-line. This, with an iron, bomb-proof upper deck, will render the ship invulnerable to the heaviest shot, and secure in every circumstance in which she can be assailed either by sea or from the land.

"Having stated this much, I would direct attention to a new and important branch of manufacture, which in all probability will shortly come into existence, and that is the production of wrought-iron in very large masses. It is not yet determined in what form these uses will be required, but I have considered it my duty to direct attention to the subject, in order that the ironmasters of this country may be prepared to meet a large demand at a comparatively cheap rate."

IMPREGNABLE BATTERY.

Captain Ericsson has engaged to construct an Impregnable Battery for the American Government, which is thus described in the *Scientific American*:—The structure consists of three principal parts—viz., a shallow-decked vessel with perpendicular sides, dead flat bottom, and pointed ends. Under this shallow vessel a second and deeper vessel is attached, with raking stem and stern, perfectly flat bottom, and sides inclined at an angle of 51° to the vertical line. This lower vessel does not extend the entire length or breadth of the upper one. It is in free communication with the latter, the bottom of which is cut out corresponding exactly with the top line of the lower vessel. The third principal part consists of a cylindrical turret placed on the deck of the upper vessel. This turret contains the armament, which it effectually protects. We have only to add that a screw propeller is applied aft of the raking stem of the lower vessel, and aft of the propeller an equipoise rudder, both of which are thus hidden under the upper vessel, by which they are most effectually protected ; the anchor being, in like manner, protected by the forward projecting part of the upper vessel, within which it is suspended in a cylindrical chamber open from below. A steam-engine, boilers, and blowers, all snugly stowed in the lower vessel, complete the general arrangement of the battery. The upper vessel is built of iron, is 174 feet long, 41 feet 4 inches wide, and 5 feet

and most invulnerable ships in the world." The design for both of these sister ships was adopted by the Admiralty, and the building of the former commenced in 1859—previous to the retirement of Lord Derby's Government from office. It was in the same year, but not until subsequently to that event, that the *Defence* and *Resistance*, the *Hector* and *Valiant*, were ordered ; the inferiority of which, even to *La Gloire*, Captain Corrie will not dispute. This gallant officer held office at the Admiralty at the time when the *Warrior* was ordered to be built.

extreme depth. The draught of water will be 3 feet 9 inches, and consequently the projection above water line will be only 18 inches. A wooden bulwark, composed principally of white oak, 30 inches thick, protects the side of the upper vessel and extends down to the bottom, being thus 5 feet deep. This bulwark is secured to the vessel's sides in a peculiar manner, requiring no through bolts. An armour, composed of rolled plate-iron, in all 9 inches thick, covers the bulwark from top to bottom, extending all round the vessel. The stem and stern being both pointed at an angle of 80°, the armour will present a sharp wedge at each end of the vessel of enormous strength. The deck, as it must be shellproof, is made very heavy. It is composed of oak beams, 10 inches square, placed 26 inches apart, the deck plank being 8 inches thick, covered all over with double plating, 1 inch thick. The lower vessel is 124 feet long, and 34 feet wide at the junction with the upper vessel, and its depth is 6 feet 6 inches. This lower vessel is built quite light, as it is perfectly protected by the upper one. The manner in which this necessary protection of the lightly-constructed lower hull, propeller, rudder, and anchor is attained, is the most important feature of this singular structure.

The constructor, we find, instead of relying on the water as protection, brings the lower body within such angles that shot cannot strike without first passing through water for a distance of more than 25 feet, and then striking at a very acute angle, 10° at the most; while the propeller, rudder, and anchor cannot be reached by shot at all. The turret, within which two guns of the largest calibre are worked, consists of a cylinder 20 feet internal diameter, 9 feet high, composed of 8 consecutive rings, each 1 inch thick, all firmly bolted and riveted together. The top is covered with a shellproof flat roof, placed 6 inches down the cylinder; it consists of forged beams covered with perforated plate-iron. Several sliding hatches, composed of 2-inch thick plate-iron, give access to the turret from above. The portholes are circular, and placed 3 feet above the decks. The guns will move on slides made of forged iron extending across the turret; the carriages, also composed of wrought-iron, are made to fit the slides very accurately, these latter being planed for that purpose. The circumference of the turret rests on a turned composition ring inserted in the deck; but the weight is sustained principally by a vertical shaft, 10 inches diameter, which rests in a cup supported by a bracket firmly bolted and braced to the main bulkhead of the vessel, about half-way down. A spur-wheel, 6½ feet diameter, 11 inches face, is attached to the turret shaft. By means of the spur-wheel and intermediate gearing, actuated by a double cylinder engine, the turret will be turned and the guns pointed in any direction. A rod, connected with the reversing gear of the engine, passes through the vertical shaft, and enables the person in charge of the guns to control the aim. For a contest with iron-clad ships carrying the heavy ordnance recently devised in Europe, Captain Ericsson proposes to dispense with two of the outer plate rings of the turret, and to attach in their place

staves of rolled iron, 4 inches thick, thus presenting an aggregate thickness of 10 inches of plating, besides the internal skeleton.

THE AMERICAN IRON-CLAD FRIGATE.

VERY few of our readers, probably, are aware that, as long back as four-and-twenty years ago, the American Federal Government recognised the importance of having armour-plated ships; and, aided by one of their best engineers, Mr. Stevens, worked out some of the chief difficulties of this method of construction, and actually commenced an enormous armour-ship at the dockyard at Hoboken, New York, in 1842. Towards the expenses of this great vessel the Federal Government at different times granted some 500,000 dollars, and the Messrs. Stevens, the builders, spent about 200,000 dollars of their own money; when, in 1850 and 1851, the Government would grant no further funds, Messrs. Stevens very prudently declined further outlay on their own account, and the works on the vessel in consequence gradually languished and stopped, leaving this most curious ship still on the stocks, and but half finished. Now, however, public interest in the plan is revived, and as only 500,000 dollars more is requisite to complete the vessel, the works on it are resumed. It is in its way a most curious vessel, though not, perhaps, a very formidable one, on account of its principles of construction, armour, and armament. When Mr. Stevens first contemplated the idea of an Armour-coated Frigate, he found from experiments that it required 16 times the thickness of oak or teak to offer the same amount of resistance to shot as iron, and that a well-made 4-inch slab of wrought metal was equal in resistance to 5 feet 4 inches of oak. According to this theory, then, the sides of our new *Warriors* are equal in resistance to a thickness of 8 feet 10 inches of oak or teak. Mr. Stevens's object, however, was not so much to stop an enemy's shot as to have his plates at such an angle as would give them a different direction, which is another thing altogether. For this purpose he determined that the armour should not be laid at a less angle than 30°, and that the plates should be of 6 inches thickness, which, at such a slope, he calculated would be equal in resistance to a foot in thickness placed upright. With armour of such immense solidity, a deep immersion of the ship became inevitable; to do away, therefore, with the necessity of coating her too heavily or over too large a surface, he devised a method by which the ship, when going into action, could instantly fill her compartments with water, so as to bring her down almost completely under the sea; submerging all but the funnel and the ridge of guns on the apex of the slanting armour-plates, which cover in her deck much after the fashion of a common ridge roof. Mr. Stevens, in fact, considered water as the cheapest and most thorough protection to be found against the flight of projectiles, on account of its perfect non-elasticity. His design, therefore, has been to get as much as possible of this cheap defence round his vessel; and, in fact, to submerge her altogether, *excepting* her ridge of guns and chimney.

The principal dimensions of this iron-clad frigate are:—

Length over all	420 feet
Breadth of beam over all	53 „
Breadth, exclusive of armour	45 „
Depth from main deck	21 „
Depth to upper or gun deck	24 „
Minimum draught of water	16 „
Draught in fighting trim	21 „
Tonnage	5000 tons
Weight of engines	548 „
Weight of boilers	266 „
Weight of hull	1447 „
Weight of armour and loading-houses	2000 „
Weight of eight guns and carriages	198 „
Weight of coal (entire capacity)	900 „
Water to immerse to 21 feet	923 „
Immersion without water	17 feet
Area of midship section at 21 feet	810 „

The bottom part of the hull is built of rolled plates one inch thick, tapering towards the top, where they meet the armour-plates, to half an inch. The iron ribs, like those of the *Warrior*, are 2 feet apart throughout, and are formed by two 6 × 3½-inch massive angle irons riveted together by their 3½-inch flanges so as to form an X. One side of the 6-inch flange is riveted to the outer skin, the other is punched for riveting to an inner skin, if on trial the vessel should be found to require it. The main or 21-feet deck, as it is termed, is wood plated over with iron, strong enough to keep out any shells which might enter from the apertures above. Over this 21-feet deck (so called from the fact of its being 21 feet in height from the inner kelson) the armour-plates, 6 inches thick, are built like a cover, sloping inwards at an angle of 30 degrees for about 15 feet, when they terminate in a flat armour deck, on which the guns are placed fore and aft and the loading-houses are built. Externally, however, this armour-plate projects at each side beneath the water outside the 21-feet deck, till it meets the inch plates which form the bottom of the vessel, so that the section is almost the same as that which would be presented by a frigate plated and built on Mr. Jones's plan of angular armour. The main or 21-feet deck is supported by the sides of the ship, and by trusses of boiler-plate placed upright from the bottom of the vessel. Over the engines this iron deck is supported by the engine frames, and at other points secured by cross bulkheads. Longitudinally with the sides of the vessel are two lines of plate girders, passing along the upright trusses, bolted to the deck beams; so that the main deck is, in fact, secured to every part of the ship, and forms both a tubular and trussed girder of the whole fabric. About 200 feet from the bows, beneath the main deck, is the boiler compartment, which extends back to the centre of the ship, where the engine compartments commence, which again extend 52 feet further aft. This portion in action would be wholly submerged at its vulnerable parts several feet below the water, and protected from above by the angular cover of 6-inch armour-plates. In front of the boilers are placed blowers and pumping engines, and near these again are the coal bunkers and the compartments for the water by the admission of which the vessel is to be brought down to her fighting trim, and immersed all but the peak of her gun-deck. Above the 21-feet deck is what is called the 14-feet deck, being, in fact, the space between the 21 feet and the armour cover over all.

There are two screws to this vessel, one under each quarter, and each screw, of course, leading to its own set of engines, placed on each side of the vessel. The ship, like the *Warrior*, has no external keel, but the inner keel is a box girder two feet high and two broad, on which is laid a railway for sending the trucks of coals from stem to stern. The engines are so arranged that there is a free passage for this tramway throughout, furnished with water-tight iron doors at all of the many cross bulkheads. The lines of the ship are remarkably fine, and the bottom flat, like that of the *Warrior*. The corner of the vessel at the water-line is formed by the angular coat of armour falling down over it, but above this, like the bulwarks of an ordinary ship, a common timber siding outside the angular armour-plated deck is continued to a height of seven feet, in order to get as much steadiness and buoyancy as possible. The mean angle of bows and stern is about

14 degrees, and the proportion of length to beam is as nearly as possible that of the *Great Eastern*, or about eight to one. The eight engines (four to each screw shaft) are placed in the centre of the ship. The two screw shafts, lying side by side, are eight feet apart at the centre, from which they start, but diverge as they run towards the stern to a distance of 22 feet asunder. They also point down a little to get a better hold in the water, being a foot lower at the screw ends than at the engine. Each shaft is 184 feet long, composed of sections coupled together, and having a *maximum* diameter throughout of 17 inches. The four cranks of each shaft stand at the four quarters of a circle. The cranks are forged in, and each crank section is coupled to the next. The engine-framing is in arches, passing under the 21-feet deck, and bolted to the bottom and sides. The cylinders stand perpendicularly between the shafts and the side of the ship. Each is of 45 inches diameter and 42 inches stroke. Above these and athwartship is the wrought-iron "walking beam," 6 feet long. Between each pair of engines is an air-pump, 40 inches diameter with 21 inches stroke, which is driven by a lever and rod from the "walking beam" above. Upon each cylinder, towards the side of the ship, is a valve-chest, containing a balanced slide valve, which is worked by a link motion (the common valve gear) that forms a variable cut off and reverse gear of the simplest kind. All the various crank pins and connecting rods are hollow, and furnished with induction and return pipes, which keep a continual stream of cold water running through them, to check heating. The boilers are placed five on each side. Each boiler has two furnaces, and the upper parts are fitted with 2½-inch return flues, 10 feet long. The total heating surface of all the boilers is about 26,000 square feet. The upper passages we have mentioned converge into a tight flue, increasing in size as it runs back, and emptying itself into a funnel, 12 feet in diameter, placed nearly in the centre of the vessel. The engines are made to be worked at high pressure—60 lb. to the inch. Each of the two sets of engines is of about 1000 nominal horse-power, so that working the screws at the rate of 100 revolutions a minute will give an indicated power of 8000 horses. It is very much doubted, however, even by American engineers, whether 60 revolutions can be attained, though all speculations on this point are necessarily very vague, as neither the pitch nor diameter of the screws will be settled till it is seen how the engines themselves will answer.

The armour-plates, as we have already said, rise to a height of only eight feet above the water-line when the ship is fully immersed to her fighting trim, and here the guns stand on a ridge or platform of metal, about 25 feet wide in the stern, and from 15 to 12 feet wide in the bows. On this armour deck are placed eight guns of wrought-iron,—the four in the bows being 15-inch shell guns, throwing a shell of some 350 lb. weight, the four in the stern being 18 inch, and throwing shells of more than 500 lb. In addition to these are four angular and almost conical loading-houses (covered, like the rest of the armour deck, with 6-inch plates), one being built between each gun fore and aft. The guns themselves are left entirely exposed, their trunnions being bedded into enormous hemispheres of wrought-iron. Each of these hemispheres forms part of a turn-table, which is worked on the 21-feet deck beneath.

The whole theory on which she would fight, therefore, is this:—On the approach of an enemy, the vessel would immerse itself by taking in water till the ridge of her gun-deck was almost level with the water's edge. The men told off for loading would occupy the loading-houses, and those beneath would, with the aid of the turn-table, work round the muzzle of each gun to the entrance of the loading-house, so that each piece might be loaded, worked round again, and fired as quickly as possible. Ports, or doors, sufficiently thick, as it is thought, to close the entrance of the loading-houses against ordinary shell, protect the men inside when they have once loaded, but the gun itself, with all the men engaged in elevating and firing it, is left entirely exposed. Up to this, the fighting point, then, the whole plan of the boat is—as the invention of an engineer in 1838—full of genius. But, judged by our present standard of ordnance and iron-clad frigates, it must break down the first time it comes to be really tried—that is, in action. Apart from the fact that the guns at three feet from the sea would be "awash," even in the calmest weather, it would be impossible to submerge the ship to her fighting trim in the presence of even a strong breeze. Granting, however, that she could immerse herself in any weather, what becomes of the men and guns left unprotected?

The present plan of the Federal Government is to have the guns

forged of such a size as will enable them to protect themselves, or, in other words, so solidly made as that the enemy may batter at them with impunity. Such a plan might have answered in 1838, when 68-pounders were not introduced, and the Armstrong 100-pounders undreamt of. But against these weapons it will require such a gun as was never yet forged in the world to enable it to take a rap on the muzzle from a 100-pounder without receiving such an indent as will never let shot in or out of it again. What, too, becomes of the men who are to come out of their loading-houses to train and fire the ordnance in the face of riflemen clustering at the ports of an enemy? What becomes of the half-inch iron door which closes the loading-houses when struck by a percussion-shell; and, above all, what would become of the whole affair from stem to stern if the *Warrior* (which, according to the American papers, she ought to blow out of the water in ten minutes) were to steam straight at her when immersed, and send her bodily under the waves? There is very little doubt but that in a short time this Stevens's Battery will be afloat. But it will be just as much behind the iron-clad frigates of this age as the old American sailing eighty-fours, still on the stocks since 1815, are behind the screw liners of the present day.—*Times, December* 6, 1861.

UNSINKABLE IRON SHIPS.

A NEW iron steamship, named the *Briton*, built by Mr. C. Lungley, of Deptford-green Dockyard, for the mail service with the Cape of Good Hope, has undergone an official trial of speed at the measured mile. This vessel is of 1092 tons burden, builder's measurement, and the following are her leading dimensions:—Length between perpendiculars, 239 ft.; length over all, 264 ft.; extreme breadth, 30 ft. 8 in.; depth of hold, 23 ft. 11 in.; depth from top of beam to top of keel, 26 ft. Her engines, which were constructed by Messrs. C. A. Day and Co., of the well-known Northam Ironworks, are of 120 horse power nominal, with an indicated horse-power of 716. They are fitted with steam-jacket, superheating apparatus, and surface condensers, and fed by Lamb and Summers's patent boilers, which supplied plenty of steam during the first day's trial. She has a two-bladed Griffiths's screw, of 13 ft. 3 in. diameter, and 18 ft. pitch. The *Briton* made four runs on the measured mile, with the following results:—first mile, 6 min. 8 sec., or an average of 9·785 knots per hour; second mile, 4 min. 59 sec., equal to 12·040 knots; third mile, 6 min. 26 sec., equal to 9·350 knots; fourth mile, 4 min. 58 sec., equal to 12·080 knots. The simple mean of the four runs was 10·813 knots per hour, and the Admiralty mean, 10·754. Revolutions of engines, 73; pressure of steam, 24 lb.; vacuum, 25. Everything went very satisfactorily during the day, and the engines worked well, without giving any trouble from heated bearings or other cause. Great interest is taken in the *Briton*, she being the first vessel built upon Mr. Charles Lungley's patent unsinkable principle. She is divided, in the first place, by ordinary transverse water-tight bulk-

heads before and abaft the boiler and engine-room. The fore part of the ship, in front of the boiler-room bulkhead, is divided below the water-line into two entirely separate holds or compartments by a water-tight horizontal deck; and the after part of the ship, abaft the engine-room bulkhead, is also divided in the same manner by a horizontal deck. If, therefore, the bottom of the ship should by rocks or any other means, be stove in or torn away below this deck at either end, the water would be confined entirely to the lower hold or compartment, the deck forming, as it were, an internal bottom which would keep the ship afloat and seaworthy. In like manner, should the bottom be stove in or torn away above this deck at either end, the lower hold would still remain sound and water-tight, and is made of sufficient capacity to keep the ship afloat and as buoyant as is necessary for safety and seaworthiness. To give access to the lower hold, beneath this water-tight deck, so as to make it available at each end for carrying cargo, a water-tight trunk is built up from the lower deck to the upper at each end of the ship, the deck being cut away within this trunk, so that cargo can be passed down by a passage way which never requires to be closed up with valves or doors, like those used with ordinary water-tight bulkheads. Should water find its way into the lower holds through breaches in the bottom, it would simply rise in these trunks to the level of the sea outside, and there remain harmless. The principle adopted by Mr. Lungley seems capable of extension, and it was spoken of very highly by one of the visitors, Mr. E. J. Reed, Secretary to the Society of Naval Architects, who referred to certain collateral advantages it possesses, such as improving ventilation between decks, giving great security from fire.

At the launch of the vessel built upon this patent for the Cape mail-service were exhibited, by means of models, the capabilities of vessels constructed upon Mr. Lungley's patent of maintaining their buoyancy under the most adverse circumstances of leakage. Plugs were withdrawn from below the water-line until first the one and afterwards the second deck was filled with water, but the hull still floated steadily, though deeper, showing that in no conceivable case would there be any difficulty in keeping a ship so built afloat until land was reached, even if by means of divers sent down below the leak could not be found and stopped.

THE WAVE-LINE PRINCIPLE.

MR. SCOTT RUSSELL has read to the Institution of Naval Engineers a paper "On the Wave-line Principle of Ship Construction," forming the concluding lecture upon that subject—two previous ones having been delivered in March, 1860, and published in Vol. I. of the *Transactions of the Institution*. In the present paper the author, after recapitulating the leading features of his previous lectures, in which the nature of the wave-line principle was set forth, proceeded to point out, with the aid of numerous diagrams, the effects of the wave-line upon the stability of ships, and on the area of the load-

water line; showed how it affected the structure of the vessel, and the form of the deck; how vessels should be built upon that principle so as to have a maximum capacity, which it appears to militate against; how the various proportions of length, breadth, and depth affect resistance; how the whole form can be so constructed as to properly arrange the balance of the ship; how this form affects the rolling and pitching of a ship; what are the places for the centres of gravity of the hull and the after body; how the wave principle affects the quality of the materials with which a ship should be built; and how it affects the properties of sailing-ships and of paddle and screw steamers. After the reading of this paper a brief discussion took place respecting the relations of length and breadth in a ship, and some other points referred to by the author.

THE RESISTANCE OF SHIPS.

THE following is a summary of a paper read before the Mechanical Section of the British Association, on "An Investigation on the Resistance of Ships," by Professor Rankine. The author states that the investigation to which this paper relates was founded originally on experimental data supplied to him by Mr. James R. Napier in 1857, and that its results were successfully applied to practice in 1858 and subsequently, to calculate beforehand the engine power required to drive, at given speeds, ships built by Mr. J. R. Napier. He refers to previous investigations of the effect of friction in resisting the motion of a ship through the water; but remarks that these investigations could not be expected to yield definite results, because in them the velocity of sliding of the particles of water over the ship's bottom was treated as sensibly equal to the speed of the ship; whereas that velocity must vary at different points of the ship's bottom, in a manner depending on the positions of those points and the figure of the ship; being on an average greater than the speed of the ship in a proportion increasing with the fulness of the ship's lines. He then explains the general nature of the mathematical processes by which the friction can be determined. Their results, in the exact form, are very complex; but they can be expressed approximately for practical purposes by comparatively simple rules. Examples are given of the application of those rules to experiments by Mr. J. R. Napier, the author, and others, on steamships of very various sizes, forms, and speed.

The principal conclusions arrived at are: That friction constitutes the most important part, if not the whole, of the resistance to the motion of ships that are well formed for speed; that its amount can be deduced with great precision from the form of the ship, by proper mathematical processes; that the engine power required to overcome it varies nearly as the cube of the speed, and as a quantity, called the "augmented surface," which is the quantity to be considered in fixing the dimensions of propellers; that the friction consists of two parts, one increasing and the other diminishing with the length of the vessel; that the least resistance for a given displacement and

speed is given by a proportion of length to breadth which is somewhere about *seven* to *one*; but that excess of length is the best side to err on. The author states as limitations to his theory, that it does not give the entire resistance of vessels that are so bluff as to push before them or drag behind them masses of "dead water," nor of vessels so small for their speed as to raise waves that bury a considerable part of their bows; and from the latter limitation he deduces precautions to be observed in making experiments on models, in order that the results may be applicable to large ships.—*Mechanics' Magazine.*

A NAVAL NOVELTY.

MESSRS. G. RENNIE AND SONS have completed, for the Emperor of Russia, a steam launch or gun-boat, intended for navigating the shallow creeks and inlets of the Caspian Sea. The hull of the vessel is composed wholly of steel plates, which are supposed to combine an extraordinary degree of strength with lightness. The length of this miniature war-steamer is seventy-five feet, her breadth twelve feet, and when fully armed, equipped, provisioned, and coaled, she will not draw more than twenty inches of water! Her armament consists of one 12-pounder rifled gun six feet in length, of 3-inch bore, and suspended on a kind of universal joint. This is placed in the fore part of the vessel, and when the portable bulwark in front of it is removed, may be depressed to almost any angle, so as to prevent an enemy creeping up under her bows, "out of shot," as has sometimes happened to craft used for similar purposes but differently armed.

For her propulsion the steam launch is fitted with an engine of eight horse-power, on the high-pressure principle, and two small screws snugly placed one under each quarter. The speed attained by this peculiar specimen of naval architecture averages, when fully freighted, from eight to nine miles per hour. And the Messrs. Rennie have secured the privilege of constructing others by patent-right. It is said, however, that the Emperor of the French is having several gun-boats built at Toulon on plans nearly identical, but of larger dimensions.—*Mechanics' Magazine.*

NEW BOAT-LOWERING APPARATUS.

OFFICIAL trials of the system of instantaneously disconnecting boats from their falls, on being lowered from a ship's davit on any sudden emergency, have been made on board the steam tender *Lucifer* at Portsmouth. The boat was lowered three times with the most perfect success, so far as the inventor of the system pretends to go—the instantaneous freeing of the falls from the boat at the moment required by the person in charge of her. To obtain this result, *the boat is fitted with* an iron shaft running along the boat's *kelson and connected with* an eccentric under the sternsheets; the *latter, worked by a small* hand lever, throws the shafting forward

or aft as may be required. On this shafting, in a line with the boat's falls, are stout claws, or teeth, immediately in front of each of which are stout metal rollers. From the after part of each roller run three-inch square casings, level with the boat's thwarts. The lower block of each fall has its hook prolonged into a stout bar, sufficient to reach the shafting in the bottom of the boat, and terminating in a semicircular link moving upon a stout iron pin. To hoist the boat up to the davits from alongside, the bars attached to each block are passed down the casings until the semicircular links touch the bottom, when the lever, thrown forward by the hand of the man in charge of the boat, the claws of the shafting catch the links, and jamming each under its roller, it is locked by the eccentric in that position. A pin inserted abaft adds to its security. It will therefore be seen that to lower the boat, the falls having been cleared in the usual manner, and the crew having taken their seats, the lowering from the ship commences in the common way. The officer in charge of the boat, with his hand on the lever, has the power of freeing the boat from its falls at any moment he sees a fit opportunity, and releasing both ends of the boat at the same instant. In this certainly consists the merit of the invention claimed by the inventor, who does not prefer any claims to give the boat headway prior to clearing the ship, as in Clifford's plan. The invention is of a somewhat analogous character to the late Captain Kynaston's, whose disengaging hooks were also of a very similar character to those adapted for a like purpose, in 1833, by Lieut. Waghorn. The above system of lowering, however, professed to be, and certainly appears so, a more certain and instantaneous method than either Kynaston's or Waghorn's. Webb, the inventor, is a carpenter's mate on board Her Majesty's ship *Illustrious*.—*Hampshire Telegraph.*

SHIP-BUILDING WOODS.

PROFESSOR CRACE CALVERT is making an investigation for the Admiralty of different kinds of Woods used in Ship-Building. It appears that the Professor is at no loss to explain why so many of the fleet of recently built gun-boats became rotten, and others escaped untouched. He finds the goodness of teak to consist in the fact that it is highly charged with caoutchouc; and that, if all the tannin be soaked out of a block of oak, it may then be interpenetrated by a solution of caoutchouc, and thereby rendered as lasting as teak. A few years ago an enterprising individual spent 30,000*l.* in trying to introduce a new wood for ship-building purposes from South America, where it is known by the name of Santa Maria; but the dockyard authorities could not be persuaded to take it into use, and the imports were entirely neglected. This is one of the specimens investigated by the Manchester Professor; and he finds it to be sound and resinous, and but little inferior to teak. Of the durability of teak there can be no question.

The superiority of foreign woods over English oak could not be too *strongly expressed.* If English oak has hitherto stood so high,

it must have been owing to our ignorance of the valuable properties of some of those grown in tropical climates, in which the soluble and highly decomposable tannin of oak is replaced in some instances by resins, and in others by substances similar to caoutchouc. This is the case with Moulmein teak, Santa Maria Mora wood, and Honduras mahogany, which gives to them a great advantage over oak for iron ship-building. Thus he has found that, in the same time and under similar circumstances, oak will attack iron twice and three times as rapidly as the woods above mentioned. He has also remarked that cubes of wood left in contact with water for five months lose respectively the following per centages of their weight :—Unseasoned oak, 24 ; seasoned oak, 12 ; African teak, 3½ ; Mora wood, 4 ; Honduras mahogany, 3 ; Santa Maria, 1·6 ; Greenheart, 5·6 ; Moulmein teak, 1·7. The facility of mildewing or decaying is as follows :—Unseasoned oak, rapid ; seasoned oak, much less ; African teak and Honduras mahogany, limited ; Mora wood, Santa Maria, and Moulmein teak, none. He had found a great difference between oak felled in summer and that felled in winter. The oak felled in winter was rich in tannin, while that felled in summer contained little or no tannin, but a large quantity of gallic acid ; and in examining some specimens of wood from the unsound gun-boats furnished to him by some of Her Majesty's officials, he found that the chemical composition of the unsound gunboats was identical with that of unseasoned summer-felled oak.

NEW RUDDER.

A NEW plan for an Auxiliary and Reserve Rudder, invented by Mr. W. R. Mulley, has been exhibited at Lloyd's, where it seems to have been generally approved of. It is about half the superficial area of the main rudder, oblong shaped, and formed of separate bars of copper or iron, in such a manner as will allow it to twist (its action resembling that of the fin of a fish) in and out of the quarter where it is hung at an optional depth below the water-line, and when not in use recessed so as to take the shape of the bottom, leaving no projection whatever. The inventor points out that for ships of war it affords especial advantages, since "it would enable the iron-cased batteries to thread their way through narrow and intricate channels that with their present means of steering they would not attempt, while in such ships as the *Warrior* it would not only greatly facilitate their powers of manœuvring, but serve as a reliable resource in the event of the main one being shot away, a casualty much to be feared now that rifled cannon will be used with such precision, the auxiliary itself being secure and out of harm's way."—*Mechanics' Magazine*.

NEW ADMIRALTY NIGHT SIGNALS.

IN these New Signals, the inventor, Mr. W. H. Ward, has succeeded in embodying the whole of the improvements which have been suggested from time to time by the authorities of Woolwich

Dockyard in their investigations during the last eighteen months, as well as by the Lords of the Admiralty themselves at their various inspections of the invention during the progressive stages of improvement. The system now presents an entirely new feature, the dimensions, weight, and efficacy of the apparatus having been totally changed.

THE NATIONAL DEFENCES.

A PAPER has been read to the Institution of Civil Engineers on "The National Defences," by Mr. G. P. Bidder, jun., B.A.

The author commenced by stating that it was not his intention to offer any opinions or to propose any schemes of his own, or to dogmatize on those of others; but merely to bring together and arrange the several questions requiring consideration, so as to facilitate their discussion. The subject was one of intricacy, from the changes which modern improvements were necessitating in the art of warfare and in the means of defence, as well as from the apparent want of any clearly-defined principles of construction. Its importance was undeniable, and might be judged of from the fact that, during the last eight years, 29,000,000*l.* had been expended in the maintenance and reconstruction alone of the navy—about 8,000,000*l.* representing the value of new ships—besides which, 12,000,000*l.* had been recently voted for the construction of military coast defences.

The first question which arose was, whether reliance should be placed on the navy alone, and the energies of the country be devoted to the task of rendering it of such a character and strength as would ensure to Great Britain the mastery of the seas, especially of those surrounding these islands; or, whether a part of the resources of the nation should be employed in providing a supplementary protection to the shores by means of land fortifications. The insular position of Great Britain rendered it peculiarly liable to invasion at a great number of points, which could not all be protected by land fortifications. But an enemy making such an attempt must have ample means of transport, as well as convenient ports of embarkation. Now, on the French coast there were but three ports fit for such a purpose—Cherbourg, Brest, and L'Orient; and there were not any others between the Cattegat and the coast of Portugal, excepting Flushing. Again, if the Russian fleet desired to combine with that of France, it would have to force a passage through the Straits of Dover, or sail round the whole of the island. The substitution of steam-ships for sailing vessels, while it increased the rapidity and certainty with which troops could be transported, at the same time augmented the efficiency of a marine force in protecting a given extent of coast, and gave greater facilities for watching or blockading an enemy's ports, as well as for conveying intelligence. There was scarcely a point round the extensive sea-board of this kingdom without an adjacent port or harbour capable of being rendered fit, at a moderate cost, for the reception of vessels of war, for replenishing stores and ammunition. Added to which, the railway system would enable an unlimited supply of coal, of ammunition, and of warlike

stores to be conveyed to these harbours at the shortest notice; and would place the entire mineral and mechanical resources of the country at the disposal of the Government. These facts were important, as in future warfare a base of operations must be provided for a fleet, as formerly for an army, and the naval base must rest on an ample supply of coal.

As the main strength of Great Britain lay in her exhaustless mineral resources and numberless harbours, so the chief strength of the power from which alone invasion might be feared lay in its enormous army. A good steam fleet interposed a barrier which must be destroyed before an invading expedition could be despatched with a chance of success. Such an enterprise as an invasion would seem hopeless in the face of a quick, vigilant, and powerful fleet. But if that fleet were worsted, the enemy would have all the advantage of his superior military organization. Such a contingency should be provided for by improvements in the coast lines of railway; and if it occurred, the labouring power of the country should be employed in throwing up earthworks, in destroying roads and bridges, and in impeding the advance of an invading army—a service in which the members of the institution might be made eminently useful.

It was contended, that any attempt to protect the shores generally, by the erection of land fortifications, must be hopeless, on the ground of expense alone. The question, therefore, reduced itself to the advisability of fortifying the dockyards and arsenals, and possibly two or three other places palpably open to invasion. This could only be effected at great cost, and the forts, when erected, would require a large number of troops to man them. If the same amount of money were employed in the construction of additional ships of war, this end might be answered quite as effectually; and an attack on the arsenals could scarcely be contemplated so long as the Channel fleet remained intact.

Assuming, then, that it was considered essential to render the Channel fleet as strong and as effective as possible, it was submitted, having regard to the modern improvements in gunnery, and the application of steam-power to propulsion, that vessels of war should be adapted to utilize and develope, to the greatest extent, the peculiar resources of this country, iron and coal—that they should also be adapted to economize the actual supply of effective seamen—that they should be designed to attain the highest speed, consistent with other qualities, by giving them finer lines and greater length, such as it was hopeless to attempt with the heavy bluff bows at present in favour. As to the material which should be used in the future navy, it had been proved that the present vessels were inadequate to support the additional weight imposed on them; and it was well known that there was an increasing scarcity of wood suitable for shipbuilding purposes. On the other hand, there was at home an inexhaustible supply of iron and the skilled labour for producing iron ships. The principal objections to the use of iron were then noticed; and it was remarked that the destructive effects of

both shot and shell were now of much greater importance than the secondary effects produced by splinters.. The advantages in the use of iron were the greater strength attainable, the comparatively little repair and renovation required, and the freedom from danger, or loss by fire.

The next point was the much-vexed question of the fortification of ships of war by means of iron plates. It had been ascertained that a thickness of iron of at least 5 inches was required to resist completely the heavier description of shot. It was clear that such a defensive armour would involve an immense addition to the weight of a ship, and must greatly impair her efficiency in other respects. Allusion was then made to the two notable examples of this system, the French vessel *La Gloire*, and the English ship the *Warrior*, the former of which was admitted to be a successful and formidable vessel, and the latter, although much larger, was but partially fortified, having her extremities unprotected. This, it has been asserted, was to render her more seaworthy; but if a necessity, which was more than doubtful, it was a great imperfection in the system. It was clear that if the *Warrior* had been constructed of the same proportions, with plates throughout of the same thickness, she would have been a faster ship and more seaworthy than *La Gloire*, on account of her greater size. It was also suggested, whether the removal of the spar deck would not so lighten the *Warrior* as to admit of the extremities being plated uniformly with the sides, without in any way impairing its efficiency. The guns would then be worked entirely from the spar deck, free from the obstruction of smoke. The bulwarks might be made sufficiently high and staunch to afford complete protection to the men. In such a ship it was contended the spars and rigging should be of a subordinate description. But on this subject of the fortification of ships, it was still a matter for inquiry whether the greatest general efficiency would not be obtained by adopting the system of protective armour on a more moderate scale.

Another point bearing on this question was, whether, owing to the greater range and accuracy of ordnance, naval engagements would not necessarily be fought at longer distances than formerly. As at long ranges the height of a target was more important than its breadth, this seemed to show the propriety of reducing ships to single decks, making them as low in the water as possible.

If these considerations were correct, it was submitted that they indicated as the proper description of vessels to be employed for Channel service, iron vessels built of great length, having fine lines, and considerable power to ensure speed, and carrying an armament of very heavy guns on the spar deck alone. That they should be as low in the water as was consistent with safety, and be protected by plates of moderate thickness throughout their whole length; and that they should be fitted with spars and rigging of the lightest description.

As to "Steam Rams," it could hardly be doubted that, if properly constructed, and of sufficient size, power, and speed, their effect among a hostile fleet, especially a fleet of transports, would be terrific.

Any attempt, however, to combine the qualities of a "Ram" with those of a fighting ship would only impair its efficiency. The expense attending the construction of these "Rams" would be very great, and the service would be very dangerous; but still it might be advantageous to construct these "Rams," if, by their means, three or four of the enemy's ships could be destroyed before the "Ram" itself.

Attention was next directed to the best mode of dealing with the present navy, and of converting the old men-of-war into efficient ships. The usual plan was to lengthen them, and to put in powerful engines and an armament of heavy guns of the same number as before; but it was suggested whether it would not be a wiser course to cut them down, so as to have all the guns on one, the spar deck, and to dispense with the heavy spars and rigging. This would reduce the weight sufficiently to compensate for the addition of the engines, and perhaps to admit of the fortification of the sides; while, by bringing the vessel higher out of the water, it would give a finer line of flotation.

It was noticed that the subject of the paper being "The National Defences," the observations on ships had been exclusively confined to those intended for service in the home seas; and were, therefore, not necessarily applicable to the case of vessels required for foreign stations.

BOAT-BUILDING BY STEAM.

Mr. Nathan Thompson has invented this new application of steam-power for the purpose of Building Boats by Steam. Now, if there is any class of work which especially demands the most skilled artisans, it is boat-building. The curves in the shears or plankings have to be so truly made, the edges of all parts so carefully bevelled and fitted, that it has long been regarded as hopeless to expect further aid from steam than that of merely turning the curvilinear saws by which the simplest of the curves are cut. All else is of necessity done by hand, and the cost is in proportion to the labour and delay. Thus, to make a line-of-battle ship's launch, thirty-two feet long, requires at the least from eight to ten days, and costs for labour alone, exclusive of material, from 12*l.* to 16*l.* By Mr. Thompson's machinery the same boat can be completed from the rough timber in five hours and a-half, and at a cost for labour and machinery of from 1*l.* 15*s.* to 2*l.*

The combination of machinery by which this enormous saving of time and money is effected is in some details merely a novel application of old principles, though as a rule all the chief implements are perfectly new, and of their kind the most wonderful samples of mechanical skill probably ever seen in this country. The factory at which the specimen machines have been erected is near Victoria Park. In Mr. Thompson's process of manufacture—

The first step is to take the rough timber, which is cut either straight or in taper form into the various requisite shapes by an ingenious improvement on the circular saw. A number of planks, afterwards to be cut up into ribs, are steamed

into a semi-flexible state, and in this condition are bent over iron frames representing the outer section of a boat's side. Held firmly in this shape they are dried, and retain for ever the curve or form to which they have been moulded. In the workshops are kept certain standard patterns of boats of all sizes made by the machinery, each part of which is numbered, and perfect accuracy with the outline and form of which is required in all portions of boats of the same size. The principle on which the implements act is capable of such an extension that the same steam cutter which bevels a lath for the side of a Thames outrigger is capable, by the most trifling alteration of the angle of inclination at which the knives work, to fashion a 50-feet oak plank for the side of a 100-ton yacht or a Margate fishing smack. The machine for sawing the ribs in parallel lines, with a true bevel as to curve, is entirely new and simple; but one of the most curious is the planking curvilinear saw, giving to the inner and outer side planks the varied local curvature required for each different part of a boat. The plank is sawn to width, and marked in chalk figures from 1 to 8, from the numbers on the standard boat in the workshop. This passes through a double cutting and planing machine. The cutters are conical in shape, the upper being convex, and therefore grooving out the plank concave, and the lower *vice versâ*. These are laid horizontally, but on a moveable axis, capable of being turned backwards and forwards on an index scaled from 1 to 8, according as the chalk figures in the plank enter the machine. Thus, by keeping the cutters transverse to the plank the curve is slight, but turning them longitudinally gives the whole depth, and so a rough board passes rapidly in at one end and emerges at the other curved inward and outward with mathematical certainty, and not only curved but planed and bevelled at the edges. Such a machine up to the present time has been deemed almost a mechanical impossibility, and the search for its discovery as futile as that for the Philosopher's Stone. By the present hand method a skilled workman would turn out four such streaks of planking a day. The machine completes 30 feet of oak plank in four minutes, or 150 streaks for the day of 10 hours. On the same scale, a workman only completes 20 bevelled ribs a day, while the machine turns out 500, with only two persons to superintend it, who, so far from being skilled workmen, may be mere boys, to stop or start the steam. The diagonal cutters for forming the irregular bevels of any angle, for the stern-pieces, stem, &c., are equally quick with their work, doing in one minute what requires two hours to accomplish by manual labour. The gratings are cut of any size or width by the motion of what is called a "drunken saw." This is simply a circular saw fixed at whatever angle with its axis it may be required, and which, with its teeth arranged in four different ways, cuts at any inclination, either simply sawing through a plank when straight or making a gap two inches wide if necessary. In fact, the whole machinery possesses the same superiority over hand labour that the power-loom has over the bygone system of knitting.

Of course, therefore, before long all boats will be built by steam machinery; and, making every allowance for wear and tear of plant, cost of setting up material, and hire of labour, it is computed that a saving of at least from 40 to even 50 per cent. will be effected to consumers at the very outset. Beyond this, however, the invention possesses other advantages, such as that of making any number or size of boats in a few hours, making duplicate pieces of those parts of the craft most exposed to wear and injury, and, above all, enabling every vessel to carry complete boats in pieces, capable of being easily stowed away, yet put together in half an hour in case of emergency. The number of boats built in the United Kingdom each year amounts to upwards of 21,000. By this new machinery, erected in a building 100 yards long by 50 wide, it is stated 60,000 boats of all sizes, from an outrigger up to a line-of-battle ship's barge, could be completed *in one year*, and at less than half the present prices. This much *Mr. Thompson's* beautiful machinery seems certainly able to effect, *and such a profitable* result in itself almost repays the eighteen years' *hard labour he has* had in gradually bringing his mechanism to its *present* perfection.—*Abridged from the Times.*

NEW MARINE GLUE.

MR. W. J. HAY, of Portsmouth Dockyard, calls attention to his New Composition for Coating Vessels, which he has patented by permission of the Admiralty.

The composition is much cheaper than marine glue, and, consequently, cannot fail to be largely adopted by the shipping interest generally. In addition to the purposes to which ordinary marine glue is applicable, the waterproof glue, from its extremely low price, may be used for caulking and paying the seams and decks of all classes of vessels, and will, consequently, become a substitute for the costly marine glue and the inexpensive pitch. Indeed, the purposes for which the glue may be used are almost innumerable; it will be found the cheapest and most durable application for iron, wood, and all other descriptions of roofing and fencing, a good substitute for bottling wax and metallic capsules, and a desirable covering for posts, piles, &c. The glue has been tested by seven years' trial, and found to answer the most sanguine expectations. For the information of those who have not proved the superiority of the waterproof glue by actual use, it may be stated that its principal ingredient is Trinidad pitch, or asphalte, which is mixed with vegetable tar and oil naphtha, or a suitable substitute. The best proportions for the ingredients which Mr. Hay has yet discovered are—Trinidad pitch, or asphalte, 60 lbs.; vegetable tar, 15 lbs.; oil naphtha, 2 lbs. Instead of the oil naphtha, 2¼ lbs. of rough creosote, or 4 lbs. of oil of turpentine may be used. In cases where it is required to pack the composition, and send it out for use, and where it may be expected to require re-melting and long exposure to heat in the melting pots while being used, he adds an additional half-pound of oil naphtha, rough creosote, or oil of turpentine. For paying seams in ships' sides or other upright or nearly upright structures with mops or brushes, a more fluid kind of composition is necessary, which may be obtained by adding to each 20 lbs. of the composition half a pint of reducing liquid; this liquid is also used to thin down the pitch when long exposure to heat has evaporated a proportion of the vegetable tar and oil. The reducing liquid is composed of vegetable tar, 12 lbs., and oil of naphtha (in which half-an-ounce of India-rubber has been dissolved), 3 lbs. For the oil of naphtha, 3 lbs. rough creosote or 5 lbs. oil of turpentine may be substituted, but the first mixture is preferred. The pitch and tar are heated separately, and well mixed; the oil is then added, and the composition is ready for use.—*Mechanics' Magazine.*

NEW DIVING APPARATUS.

THIS invention is described with some favour in the *Athenæum*, No. 1745, in a letter from Munich, where it has been exhibited. It is adapted for exploring the bottom, for pearl or coral fisheries, for bringing up samples of plants or seaweed, for laying the foundation of breakwaters or the piers of bridges, or for raising sunken vessels and treasure. A practical opportunity of testing this invention has been afforded the inventor by a commission to raise the

steamer which sank in the Lake of Constance, but everyone who saw the working of his small model was perfectly satisfied. Mr. Bauer has already taken out a patent in England.

The objections to the open diving-bell and to the helmet and diving-dress are too well known to need repetition. Mr. Bauer's invention gets rid of the objections already existing, without bringing new ones into play. His apparatus is completely closed; the diver enters through a door at the top, which is afterwards hermetically sealed, and he takes down air enough to last six or seven hours, after which it can be renewed by means of tubes communicating with the ship on the surface, or purified by the introduction of oxygen. The apparatus is of a cylindrical form, with a double bottom for the reception of water-ballast, which is pumped in or out from within, with bull's-eyes in front, on the sides, at the bottom, and overhead, a screw-propeller worked by hand from within the chamber, a rudder and a smaller screw to make it revolve on its axis. Besides these means of locomotion, it is fitted with a pair of paddlewheels for moving along the bottom, with an anchor to resist powerful currents, and with weights which can be suddenly dropped if the conductor wishes suddenly to rise. All these properties are described in detail in the specification of Mr. Bauer's Patent, dated the 3rd of March, 1860. For digging up plants, for pearl or coral fishery, or for raising specie, the apparatus is fitted in front with shovels, scoops, spoons, or tongs, which are worked from within the chamber. For raising sunken vessels, balloons are used of strong material, such as alternate layers of canvas and caoutchouc, and enclosed in a network of stout cords with an iron ring at the bottom. These balloons are lowered empty to the apparatus, and are fastened round the vessel to be raised to an iron pin previously driven in by the operator. They are then inflated by a force-pump from the ship above, and as they are all open at the neck, the air within regulates itself in proportion to the pressure of the water without risk of bursting the balloons. As soon as all the balloons are fastened round the ship and inflated, the ship rises of itself—a great improvement, it must be admitted, on all the previously existing means of operation. Mr. Bauer showed all these parts of his invention with a balloon and a considerable weight with perfect success. He took the stone, which bore the same proportion to his model that a large stone would bear to his apparatus, lowered it gradually to the spot determined, made it advance under water, on the surface, made it sink gradually while moving ahead, and then made it rise by the inflation of a balloon.

The writer of this communication greatly admired the exhibition of Mr. Bauer's model, and condemns our Admiralty for declining its adoption.

SOUTHPORT PIER.

A PIER recently erected at Southport, Lancashire, by Mr. H. Hooper, has been described to the Institution of Civil Engineers. *It was constructed* at right angles to the line of promenade facing

the sea, on an extensive tract of sand reaching to low water, a distance of nearly one mile. Its length was 1200 yards, and the breadth of the footway 15 feet. At the seashore there was an oblong platform, 100 feet long by 32 feet wide, at right angles to the line of footway. The superstructure was supported upon piers, each consisting of 3 cast-iron columns, and each column was in 3 lengths. The lowest length, or pile proper, was sunk into the sand to the depth of 7 feet or 9 feet. These piles were provided at their bases with circular discs, 18 inches diameter, to form a bearing surface. A gas tube was passed down the inside of each pile, and was forced 4 inches into the sand: when a connexion was made with the Water Company's mains, a pressure of water of about 50 lbs. to the inch was obtained, which was found sufficient to remove the sand from under the disc. There were cutters on the under side of the discs, so that, on an alternating motion being given to the pile, the sand was loosened. After the pressure of water had been removed about 5 minutes, the piles settled down to so firm a bearing, that, when tested with a load of 12 tons each, no signs of settlement could be perceived. The upper lengths of the columns had cast-iron bearing-plates, for receiving the ends of the longitudinal lattice girders, each 50 feet long and 3 feet deep. The centre row of girders having double the duty of the outside ones, top and bottom plates were added. The weight of wrought-iron work in each bay was 4 tons 5 cwt., and of cast-iron work 1 ton 17 cwt. The second bay from the shore was tested by a load of 35 tons, equally distributed, when the mean deflection of the 3 girders, in 24 hours, was 1½ inch, and there was a permanent set of half an inch on the load being removed.

The advantages claimed for this mode of construction were:— 1. Economy in first cost, especially in sinking the piles, which did not amount to more than 4½*d.* per foot. 2. The small surface exposed to the action of wind and waves. 3. Similarity of parts, thus reducing the cost to a minimum. 4. The expeditious manner of obtaining a solid foundation—an important matter in tidal work. Two hundred and thirty-seven piles were thus sunk in six weeks.

The estimated cost of the pier and approaches was 10,400*l.* The works had been completed for 9319*l.*, being at the rate of 7*l.* 15*s.* 4*d.* per lineal yard. The pier was designed by Mr. Brunlees, and the superintendence of the construction was entrusted to the author, as resident engineer, Messrs. Galloway being the contractors.

MEASURING DISTANCES BY THE TELESCOPE.

MR. W. B. BRAY has read to the Institution of Civil Engineers a paper on this subject. He found that it was convenient to have two distance hairs on the diaphragm of the level, one about $\frac{3}{20}$ of an inch above the level hair, and the other as much below, so as to read 1 foot on the staff at 1 chain, and 10 feet at 10 chains. Since, however, in focussing the instrument to any object, it was necessary to bring the cross hairs into such new focus, which was proportionally

further from the object glass as the object was nearer, the angle which the hairs subtended from the centre of the object glass must be variable, diminishing as the distance was diminished. Hence a correction was necessary, and this the theory of refraction by lenses.

In the course of the discussion on this paper, it was remarked, that the arrangement described by the author was of a much earlier date than had been mentioned. Possibly, its application might hitherto have been limited, from the want of a correction for the errors introduced in focussing the instrument, which had now been supplied. Reference was made to the micrometer arrangement of the diaphragm in Mr. Gravatt's original dumpy level. This system of measuring distances had lately been applied to rifle practice, and, for military purposes generally, it was thought that a micrometer telescope could be relied on for distances up to twelve or fifteen miles. It had also been employed for determining the speed of vessels at sea, when the exact length of the vessel was known, as well as for other purposes.

It was observed that the great improver of instruments of this kind was M. Porro, an officer of Engineers in the service of Piedmont, a detailed account of whose "Instruments pour les léves de plans," was given by M. H. de Senarmont in the *Annales des Mines*, 4th series, vol. xvi. (1849). None of the modifications in M. Porro's instruments had been introduced into this country, and yet with his micrometer scale of wires, the staff could be read off in metres at once—and, it was stated, at a distance of 800 metres the error did not exceed two centimetres.

PHOTOZINCOGRAPHY.

COLONEL SIR H. JAMES, R.E., has described to the British Association, the process of "Photozincography," by means of which photographic copies of the Ordnance maps are cheaply multiplied, either on their original or on a reduced or enlarged scale. The process is applicable to the reproduction of old manuscripts and old printed books. A copy of Domesday Book (the part relating to Cornwall taken by this means) was exhibited to the Meeting. The process consists in taking a photographic collodion negative, which is intensified by means of bichloride of mercury and sulphate of ammonia. Paper, deprived of its size, is saturated with a solution of gelatine and bichromate of potash. The paper thus prepared is exposed to the light beneath the negative, the result of which is that the parts which have been exposed to the light become hardened and insoluble. The whole is then inked with a greasy ink and afterwards washed in water, which removes the ink from all the parts except those on which the light has acted. A transfer to stone or zinc is then taken in the ordinary way, and copies are printed. Sir Henry James then described an improvement which had lately been made in the process, by means of which a reduced copy of a map or plan could be made, in which the minor detail (which would be useless on a reduced scale) could be omitted, and the names of places and other features of the plan given in full-sized legible characters.

INDESTRUCTIBLE TABLETS FOR STREET NAMES.

MR. JAMES HUNT has exhibited to the Court of Sewers, at Guildhall, specimens of some Indestructible Tablets for Street Nomenclature, manufactured by the Patent Glass Enamel Company at Birmingham. They are made of plates of wrought-iron, upon which the names of streets in letters of white glass enamel are conspicuously placed on a dark ground, so as to be read as well by night as by day. The Court expressed its approval of the specimens, and decided on bringing them into use in the City.

Nearly forty years since enamelled tablets were proposed for the metropolis by M. Langlois, a potter, of Languedoc; but the civic authorities declined the invention.

WROUGHT-IRON BRIDGES AND GIRDERS.

MR. FAIRBAIRN, President, has presented to the British Association a paper containing a series of "Experiments on the Effects of Vibratory Action and Long-continued Changes of Load upon Wrought-Iron Bridges and Girders." He said this was a subject of great importance as affecting the construction of tubular and plate bridges, and also the lattice and trellis bridges. Fifteen years ago experiments were made which led to the construction of the Conway and Britannia tubular bridges on the Chester and Holyhead Railway, and determined the form in which such structures should be designed. Since that time some thousands of bridges had been built entirely of iron. The requirement of five tons per square inch on the part of the Board of Trade appeared to be founded on no fixed principle. It was well known that the power of resistance to strain of wrought-iron depends very much upon the form in which it is combined, and unless the proportions of the parts were permanently established, the five-ton tensile strain might lead to error.

For the purpose of making experiments upon the influence of vibration in causing the rupture of beams and bridges, he had constructed a small iron-plate beam of 20 feet clear span, and 16 feet deep, representing the proportion of one of the girders of the Spey Bridge, and exposed it to conditions similar to those of a bridge subject to changes of load as produced by the passage of trains, and in proportion to the heaviest rolling load. The beam was first loaded to one-fourth of its breaking weight, and it sustained a million changes of load without injury. The load was then increased to nearly one-half the breaking weight. With this weight the beam gave way, after 5175 changes. It appeared, therefore, it was not safe to build bridges in which the rolling load would bear this proportion to the breaking weight. The beam was taken down and repaired, and the experiments were then renewed. The load was then reduced to two-fifths the breaking weight, and 25,900 changes of load were sustained. Lastly, the load was reduced to one-third, and the experiments were still proceeding, the beam being uninjured after 2,727,754 changes. In calculating the strain upon the area of the metal after deducting the rivet-holes, which, it must be

remembered, were larger in proportion in this small beam than in bridges, he found that the beam would sustain no deterioration with strains of nearly 7½ tons to the square inch. With 10 tons to the square inch the beam broke after 5172 changes. Now, as the limit of elasticity was reached at about 9 tons per square inch in ordinary boiler-plates and bridge-plates, it would appear that it was unsafe to load structures subject to a continually varying load beyond that point. Within those limits, however, there was no evidence that a deterioration of structure took place. For the present, he would advise that in all beams and girders, tubular or plain, the permanent load or weight of the girder and its platform should not, in any case, exceed one-fourth of the breaking weight; and that the remaining three-fourths should be reserved to resist the rolling load in the proportion of six to one. He earnestly directed attention to the laws which governed the resisting powers of girders exposed to transverse strains, to the best principles of uniting the joints, and, above all, to the selection of the best material, which, in the parts of the girders subject to a tensile strain, ought always to sustain a test of from 22 to 24 tons per square inch. The use of superior metal for the bottom of the girders would give an increase of from one-fifth to one-sixth in the strength. There was no economy—and he wished particularly to impress this on the Section—in the use of inferior iron for this purpose, and its employment inevitably led to a loss of character in the structure and danger to the public.

NEW MOTIVE POWER.

MR. NEWTON has patented an invention in which three stationary steam-tight cylindrical chambers are employed, the middle one being fitted with a turbine of any approved construction, mounted upon a vertical shaft, which turns in bearings carried by the cylinder head. This middle cylinder is connected to each of the side cylinders by means of two pipes, one of which (from each cylinder) enters the middle cylinder above the face of the turbine, and the other below the turbine. Each pipe is governed by a shutter-valve, the slats or shutters in the upper pipes opening inwards to the middle cylinder, while those in the lower pipes open to the side cylinders. These two side cylinders are connected at top by a branch steam-pipe leading from a boiler, and in the prolongation of these branches (within the cylinders) cut-off valves are mounted. By the axial motion of these valves the steam is cut off, and exhaust pipes brought into connexion with the cylinders. The working of the valves is effected by annular floats, that are suspended in the cylinders from pendent rods, and which, by means of cranks and horizontal rods, are connected to arms keyed to the bottom of the valve-spindles. To ensure the proper relative action of these valves, the upper ends of their spindles are connected together by means of short levers, which they carry, being coupled by an adjustable coupling-rod. A driving pulley is keyed to the turbine shaft for transmitting the rotary motion of that shaft to the mechanism to be driven by the engine.—*Mechanics' Magazine.*

STEEL RAILS.

A PAPER has been communicated to the Institution of Mechanical Engineers at Sheffield, by Alderman John Brown, on "The Manufacture of Steel Rails and Armour-Plates." Amongst the most important methods hitherto used, it remarked, were forming the wearing surface of the rail of steel, case-hardening the outer coat of the ordinary iron-rail, and using rails of puddled steel. These processes were to some extent successful, but were open to serious objections. The introduction, however, of Bessemer's system had opened out a mode of producing a pure, homogeneous, hard, and tough material, most admirably suited for the manufacture of rails; and though their cost might prevent their extensive use, yet in every railway there were certain places where they might be laid with economy, as, for instance, where the traffic was more than ordinarily severe. Specimens were shown, exhibiting homogeneousness, toughness, and ductility of metal. The tensile strength was upwards of forty tons per square inch. Cast-steel rails were not an absolute novelty, having been used with success at the Derby station; but those were made by the old method, and it was impossible to introduce them commercially, on account of their great cost. Still, the experiment showed their greater power of resistance; and now, by the Bessemer process, steel rails could be produced, bidding fair to become a "permanent way."

The paper then went into the subject of armour-plates, and a conversation afterwards took place upon this subject.

IRON TIRES OF RAILWAY WHEELS.

SEVERAL instances having occurred in severe weather of the Tires of Railway Wheels being broken, it was set down as a consequence of the strain arising from contraction. "But," says a Correspondent of the *Times*, "the greatest variation of temperature in the atmosphere of this country, say between that of a hot summer's day to that of a cold winter's day, will not affect the length of malleable iron more than about one inch in 100 feet. This in a tire nine feet long would be less than one-tenth of an inch; and as the strain requisite to stretch malleable iron one-tenth of an inch in nine feet does not exceed five tons to the square inch, it follows that the force exerted by contraction alone is also under five tons per square inch. But the breaking strain of ordinary malleable iron is known to be over fifteen tons per square inch, and that of good tire and axle iron over twenty-five tons; contraction alone is, therefore, not the cause of fractured tires in frosty weather. It is a known fact that tire iron of the very best quality has failed recently; also that a bar of good iron, which in an atmosphere of ordinary temperature would bend up like leather, has broken short off with the single blow of a hammer on a frosty night. I therefore conclude that frost exercises a subtle influence on the quality of iron, reducing its tensile strength, and that the recent breakages were the result of this loss of cohesive power, and not from excessive contraction."

SAFETY SIGNALS FOR RAILWAY CARRIAGES.

M. BAZIN, of Angers, has invented an apparatus which from its simplicity and efficiency has some chance of being generally adopted. It is well known that a train in motion causes a strong current of air, and it is this circumstance which M. Bazin has turned to account. A cord is placed within reach of the traveller, by pulling which a small ventilator is set free, and begins to rotate in virtue of the current, whereby it causes a bell to ring, which gives the alarm. At the same time a coloured disc is pushed out, which shows in what carriage or compartment the alarm has been given. Once in motion, the apparatus cannot be stopped, except by the guard. Thus a traveller who might be induced to play a practical joke would be discovered by his own act. The experiment made with this apparatus has succeeded perfectly.—*Galignani's Messenger.*

STATION INDICATOR FOR RAILWAYS.

A NOVEL and practical arrangement for Indicating the Names of Various Stations on Railways, during the journey of a train, is the subject of a patent by Mr. Leigh, of Dalston; the object being to provide railway carriages with an indicating apparatus which will show to railway travellers the several stations on the line as they are approached or arrived at by the train. The inventor proposes to present to view the names of the several stations on the line in their proper succession, causing them severally to pass out of sight as the succeeding station is approached or arrived at. To this end the names of the stations are to be printed on a band of silk or other material, the ends of which are attached to rollers, one of which is capable of being driven by suitable gearing set in motion by the progress of the carriage, or otherwise, after the manner of counting apparatus, while the other roller is maintained or kept in its position by means of a spring or other convenient contrivance, whereby the band will be kept in tension.

Another form of apparatus consists in arranging the names of the stations radially on a disc, so that they may be brought into view in succession by means of an intermittent motion imparted to the disc by suitable mechanism set in action by the progress of the train, or otherwise. In order to actuate the indicating mechanism, a projection at the side of one of the rails, or placed in some convenient place between the rails, may be arranged to raise a rod and rock a lever, and thus create the motion which will produce the intermittent axial motion of the disc or roller that carries forward the band or name plate. Or the motion may be derived from one of the carriage wheels instead of from a fixed projection on the line: or it may be set in motion by rods or ropes, which may be worked by the guard. Other plans may also be adopted for giving motion to the travelling surface which carries the names of the stations, so as to present them within view of the passengers in the compartments of the carriages to which the invention is applied; but in conjunction therewith it will be desirable to use an audible signal for calling the

attention of passengers to every change of the indicator.—*Mechanics' Magazine.*

STREET RAILWAYS.

In the *Year-Book of Facts*, 1861, pp. 75-80, we described Train's new Street Railway. The experimental portion, between the Marble Arch, Hyde Park Corner, and Bayswater, has been taken up, by order of the Commissioners of the Roads, much to the satisfaction of the neighbourhood. But Mr. Train, like another Briareus, has laid his tramways in Victoria-street, Westminster, and from Kennington Park to Westminster Bridge.

In the Blackfriars-road a new sort of tramway has been commenced by Messrs. Mowlem, Burtt, and Freeman, contractors, on the west side of the Blackfriars-road, to the Elephant and Castle, Newington-butts, *viâ* the London-road. Instead of the tramway consisting of smooth iron plates, these are in blocks of cast-iron, about 18 inches square and 4 inches in thickness; the surface being chequered with small oblong blocks protruding, so as to give horses good footing when passing over the metal way; but, it is said, not causing the slightest obstruction to the wheels of vehicles travelling upon it. The blocks are laid upon a substratum of concrete, and will be on a level with the other portions of the road. The metals and timber of the tramway have been lifted in the Bayswater-road, from thence to the Surrey side of the water, to form a part of the connecting link of street-railways from the Victoria and Pimlico Railway Station to Blackfriars and London Bridges.

In Liverpool a "Street Railway and Omnibus Company" (limited) has been started by the principal omnibus owners of the town. They are said to claim no monopoly in the right of way, and to be prepared to incur all cost connected with the laying down and removal of the tramways. Mr. Newlands, the borough engineer, we may observe, has made a report to the town council, disapproving generally of Mr. Train's plan of rails, and recommending for adoption the plan tried in Manchester, of mere wheelways, and a guiding line an inch deep in the middle of the horse track. The whole matter has been referred to the Health Committee.

Mr. Haworth has read to the British Association, a paper explaining his patent for improvements in street railways, by the addition of a fifth or perambulator wheel to the carriages, running as a guide in a central groove between the trams. It was calculated that a saving of 35 per cent. would be effected by this plan. Mr. Vignoles expressed his opinion that if any street railway were ever adopted, Mr. Haworth's system would be the one. He had never seen a more promising system.

NEW SYSTEM OF RAILWAY.

A poor wheelwright of Paris is stated in the *Morning Star* to have devised the following means of facilitating field labour by a Railway consisting of a series of rails fitting one in the other like a

succession of ladders laid flat upon the ground; over these the carts roll quietly along, let them be ever so heavily laden. One great advantage of the system is the facility with which the rails are laid down and taken up. In one hour a hundred mètres may be planted. The tedious carting of crops through wet and muddy fields is hereby avoided. The experimental rail was seventy-five centimètres in width. The carts filled with produce, whether pushed or drawn by one single person, were of one cubic mètre, and moved with the greatest ease.

This new system of portable railway has been experimented upon with perfect success at the forage markets of Compiègne. The gauge is seventy-five centimètres; and the waggons, holding a mètre cube, can be easily pushed by one person.

WARMING RAILWAY-CARRIAGES.

In France, the waste steam from the engine, instead of being allowed to escape into the air, is conducted from the escape-pipe by means of a vulcanized India-rubber tube, to copper pipes, through which it circulates under the seats and flooring of the carriages. As soon as the train is set in motion, the steam begins to circulate through the pipes, and warms the carriages, first, second, and third class equally; and being connected with each other by india-rubber tubing, they can be immediately detached or reunited at pleasure. In a trial on the Lyons line, two thermometers placed in first-class carriages marked 60° Fahrenheit during the whole journey; and in the second and third-class carriages the temperature was sufficiently elevated to allow of the longest winter's journey being accomplished without discomfort.

SUBMARINE TUBE RAILWAY ACROSS THE BRITISH CHANNEL.

Three French engineers have proposed tunnelling under the Channel; five English and two French proposed submerged tubes; a Frenchman an arched railway or tunnel on the bottom; and an Englishman a mammoth bridge. To these may be added the plan of Mr. James Chalmers, who, according to the *London Review*, proposes a Channel Railway to connect England and France by a tube, which, having a powerful tendency to rise, is to be weighted with iron boxes filled with rough stones, the whole to be covered with an embankment of stones, which will form a ridge from shore to shore 150 feet wide at the base, 40 feet high, and from 40 to 120 feet below the level of low water.

This tube is to have three ventilators—one in mid-channel, one about a mile from either shore. As the tube is to be eighteen miles in length, passengers will never be further from the light than four miles and a half; but the projector proposes a system of artificial ventilation, by up and down draughts, such as we already have in our coal-mines. Mr. Chalmers calculates that the cleanly-painted light-coloured iron and a thousand double lamps, one every thirty-five yards, will give a cheerful aspect to this ocean roadway, and render it an agreeable contrast to the noise, and damp, and darkness of an *ordinary tunnel, or* even the miles of uninviting scenery that often

meet the eye in broad daylight. The noise in the tube can be reduced to a minimum; unlike tubular bridges suspended in the air, the sound and vibration of the iron will be deadened and neutralized by the equability and elasticity of the pressure without; and as the situation of the roadway will admit of a perfectly united rim, the sensation that travellers will experience on entering the Channel railway will be akin to what we feel after walking on a gravelly road with thin shoes, when we step upon the downy sward of a lawn!

The projector proposes to make his tubes in lengths of 400 feet, and 30 feet in diameter, and to join them under water. He gives, indeed, the most minute directions as to the manner in which these huge masses of iron are to be floated out and then sunk, so that they shall be joined together impermeably in the surrounding water. To read his scheme it would really seem as though the whole thing could be done with as much ease as we join gas or water pipes above ground!

THE METROPOLITAN SUBTERRANEAN RAILWAY.

A QUICK and safe means of communication beneath the overcrowded streets of London has always been the great ideal of engineers; and is now in course of accomplishment by Mr. John Fowler. The present powers of the Company only allow them to carry their line from Paddington to Finsbury-circus, a distance of four and a half miles; and of this length, more than three miles, extending from Paddington to the Victoria-street Station, are in many parts quite complete, and in others nearly so, with perfect working junctions with the Great Western and Northern Railways. It commences at the Paddington Station, and is continued thence, in an almost direct line, towards the New-road, passing beneath the Edgware-road at right angles, and intersecting in the same manner Lisson-grove-road and Upper Baker-street, skirting along, beneath, and just outside the southern extremity of Regent's Park. Thence it passes under the houses at the eastern extremity of Park-crescent, continues beneath Tottenham-court-road into the New-road, and, passing close by Euston-square, turns at King's-cross to effect a junction with the up and down lines of the Great Northern Railway. From King's-cross a great part of the line is an open cutting, except for a length of about 600 yards beneath Bagnigge-wells-road and Coppice-row, where again, for the length we have said, a tunnel intervenes. From this to the Victoria-street Station it is nearly all a fair open cutting. From the station to be erected in Victoria-street, the line is to have two branches, one intersecting Holborn-hill, or rather Skinner-street, and, continuing its course due south under the site of the old Fleet Prison, effecting a junction with the Chatham and Dover line, which is to cross the Thames at Blackfriars. The other and more important branch—in fact, the main line—is to be continued under the ground north of Smithfield and south of Charterhouse-square, and will pass beneath Barbican into Finsbury circus. At this terminus it is intended, for the present at least, to stop. As it is, even completed to the Victoria-street Station, and communicat-

ing with the Chatham and Dover-bridge when finished, the facilities which it will offer to rapid travelling will be immense. A person starting from Brighton or Dover will be put down almost at his own door at Bayswater, instead of, as now, taking almost as much time to travel from London-bridge to Bayswater as to perform a long journey by rail. In like manner, those coming from the North—from Edinburgh, Liverpool, or Manchester—will be able to book direct through to Dover or Southampton without the loss of a minute on their journey. It is not too much to say that for passengers pressed for time the two or three miles' interval between the northern and southern stations of the metropolis are equal in actual delay to 200 or 300 miles' distance on an unbroken journey. By the condition of taking the line underground, sewers were not to be interfered with, gas-pipes and water-pipes not to be touched, churches to be avoided, and houses to be left secure. With these drawbacks, Mr. Fowler was at liberty to take his tunnel through a labyrinth of sewers and gas and water mains if he could. At every step, vestries, gas and water companies, and the Board of Works had to be consulted, and but for the kind and liberal spirit in which the Company was met, and the fair efforts which were everywhere made by these bodies to help them over their great difficulties, the railway could never have been made at all. The following are the constructive details of the portion of the line completed—

To the Victoria-street Station the line is nearly 3¼ miles long, having stations at Paddington, Edgware-road, Baker-street, Portland-road, Euston-square, King's-cross, and Victoria-street. From west to east the average slope downwards of the whole line is about1 in 300 feet,though after entering the City it again rises, but there is no steeper gradient throughout than 1 in 100. Its greatest curve is of 200 yards' radius, and its greatest depth from the ground above to the rails not less than 54 feet, and there are not more than 1200 yards of straight line throughout. The span of the arch of the tunnel is 28½ feet, its form is elliptical, and its height 17 feet, except in the parts where there is great superincumbent pressure, when the form of the arch is altered to give it greater strength and to take the crown to a height of 19 feet. The foundations of the tunnel go from four to five feet into the solid ground on each side below the rails, except in some few places, where the close vicinity of very heavy buildings rendered extra strength necessary, and here the tunnel has been driven like a shaft, and is a solid ring of massive brickwork above and below; in fact, in all parts of the tunnel itself the most zealous care has been taken to ensure the structure being everywhere greatly in excess of the strength it actually requires. Thus, even the lightest parts of the tunnel have six rings of brickwork, though railway arches of seven feet greater span are never built with more than five. The outer side of the arches also are filled in with solid beds of concrete, and the whole covered over with a layer of asphalte to keep it water-tight. In fact, the tunnel has been formed on what engineers call the "cut and cover" principle; that is, the ground has been opened to the base of the intended tunnel, the tunnel built, covered with concrete and asphalte, and filled in again with earth, and the roadway paved over as before. On this plan, and working in 12-feet lengths, the tunnel has actually been constructed at the rate of 72 feet a week, quicker than any work of the kind has ever yet been accomplished. It has not all, however, been completed at this rapid rate. Passing near churches and heavy buildings the tunnel has been regularly driven in four-feet lengths by skilled miners; and such portions advanced but slowly. At the western extremity, where the soil was a fine gravel, the works were at one time greatly impeded by the water, which in that district is abundant everywhere at about 14 feet from the surface. This it was useless to try pumping out, as the pumps brought up sand and gravel as well as water, and would, had the attempt been persevered in, have brought up the very foundation of the surrounding houses also. It was necessary at last to make regular drains into the low-level sewers, in order to keep the works free

Through the gravel and through the London clay the labour has been very easy, but in parts where there was light, loose, sandy soil a great deal of difficulty was experienced. All the really difficult parts have now, however, been surmounted, and the tunnel built in the most solid manner. The lines of rails are laid through many lengths, each line being double gauge, intended for both the broad and narrow traffic. Where the junctions have been effected at Paddington and King's-cross it was necessary at the point where the switch rails joined to widen the tunnel, and at these parts make it, in fact, like the mouth of a trumpet. This was the most difficult operation ever attempted in either tunnelling or brickwork, but Mr. Fowler has surmounted all the obstacles in a masterly manner.

What made the work at King's-cross more difficult than all was that at precisely the most difficult part of all the junctions the great Fleet Ditch sewer crossed it right through the crown of the tunnel arch. As the sewer, of course, could not be disturbed, the obstacle was met by carrying it across, slung, as it were, in a powerful cast-iron trough, and there it now hangs, peering through the brickwork like a colossal main, and with all beneath it as dry and sweet-smelling as if Fleet Ditch—that fullest and foulest of all London sewers—were 100 miles away. Mr. Jay, the contractor for this end of the works from Euston-square, has accomplished the designs in the most massive and careful manner; in fact, the works here are regarded among engineers as positive models of what contract labour should be. The stations along the line which we have already enumerated will, all but two, be open-air stations, and even those that are to be underground will be amply lit by daylight coming through apertures in the roof of the arch. But one of the greatest difficulties of all the many that had to be overcome consisted of constructing an engine that should be at once of great power and speed, capable of consuming its own smoke, and, above all, to give off no steam. Ordinary engines passing through tunnels so completely enclosed would in a very short time fill them with such a mixture of steam and smoke as would be very nearly suffocating, would make signals almost useless, and, in short, render the traffic not only disagreeable but dangerous. To avoid all these complicated evils Mr. Fowler has invented an engine which, while in the open air, works like a common locomotive, but, when in the tunnel, consumes its own smoke, or rather makes none, and by condensing its own steam gives off not a particle of vapour.

In a trial trip, as long as this engine remained in the open air at Paddington it fizzed and simmered like any other locomotive; but the instant it entered the tunnel it condensed its steam, and scarcely a mark of vapour was perceptible, while, from the flues into the smoke-box being damped, not the least smell of smoke was given off. As upon the success of this engine the practical working of the line depends, the result of the experiment was watched with a good deal of anxiety. It, however, was perfectly conclusive: not even the most distant lamps in the long vista down the sides of the tunnel were dimmed in the slightest degree—in short, nothing could have been more entirely complete and satisfactory. Having gone through the tunnel, the engine returned down the same track, and when in the centre of the tunnel, to show the difference, the engine was allowed to work upon the usual plan, and in a few instants the whole place was full of vapour, which was so thick that even when the visitors returned through for the third time the lamps were still scarcely visible. The through trains from east to west, and *vice versâ*, will, we believe, be arranged to start every ten minutes, to accomplish the distance from end to end in thirteen minutes, at a rate of fares which, it is said, will compete with those of the cheapest omnibuses. If this is so, the line ought to prove remunerative to the shareholders, though whether it is so or not it must be an immense convenience to the public.—*Abridged from the Times, Nov. 30, 1861.*

PNEUMATIC DISPATCH COMPANY.

EXPERIMENTS have been made at Battersea, to test the efficiency of this novel mode of transmitting goods and parcels proposed by the above-named Company. The mechanical arrangements in connexion with the experimental line of cast-iron tubing, for more than a quarter of a mile along the river-side, are few and simple. Under a temporary shed a high-pressure steam-engine, of thirty horse-power, made by Watt and Co., and having its cylinder placed at an angle of forty-five degrees, is erected, and it gives direct motion through the medium of a crank to a large disc of sheet-iron. The disc runs on tubular bearings, and narrows from about two feet six inches in breadth at its centre to three inches at its circumference, its diameter being eighteen feet. Its interior contains simply four arms, to which the sheets of iron are fastened, and which serve as fans or exhausters. Through the hollow bearings, upon which the disc is made to rotate at a speed of from 150 to 200 revolutions per minute, a communication exists with a vacuum chamber below; and by the laws of centrifugal action the latter is speedily exhausted, to a certain extent, of air. The speed, in fact, of the disc determines that extent, and a water barometer registers it. The air rushes out with considerable force from the periphery of the disc. Between the vacuum chamber and the pneumatic tube, which is two feet nine inches high, by two feet six inches in breadth, and a transverse section of which resembles that of the Thames Tunnel, there are fitted valves with hand levers for opening and shutting them. These may be said to comprise the whole of the motive and propelling agencies of the pneumatic system. The tube has several very sharp curves and steep gradients throughout its length, and is socket-jointed, so as to leave its interior, which is just as it came from the sand, free from obstruction. The carriages are five feet in length, of sheet-iron, and each runs upon four cast-iron wheels of eighteen inches in diameter. The rails—so to speak—are *cast* in the bottoms of the tubes, and require, therefore, no "laying" but that which the setting of the tubes themselves gives them. A few strips of vulcanized India-rubber screwed round the circumference of the fore end of the carriage constitute the piston. This, however, by no means closely fills the tube. In fact, there is fully three-eighths of an inch clear between the exterior of the piston and the interior of the tube. There is no friction; and the leakage of air does not interfere with the speed of transit.

The first public experiment made was by loading a carriage with one ton of cement in bags, and entering it into the open end of the tube. Upon a given signal, Mr. Rammel, the engineer to the Company, caused the starting valve to be opened, the water barometer showing a column seven inches in height, and the disc running at a rate of 150 revolutions per minute. In fifty seconds after, the carriage with its contents found its way into the engine-house, through a door at the end of the tube, which it forced open, and then ran forward on rails to a butt placed to stop its progress. Next two tons weight were placed in one of the carriages, and its transit occupied eighty seconds, under similar circumstances. The vacuum

was now lowered until the barometer gauge showed two inches of water only, and a dog was placed, with one ton weight of dead stock, in a carriage. The signal was made by the workmen at the open end of the tube, the communicating valve was opened, and in one minute and a-half the carriage and the dog were in the engine-house, the latter apparently not at all the worse for the exhausting process to which he had been subjected.—*Mechanics' Magazine.*

The air is exhausted, from near one end of the tube, by means of an exhausting apparatus, from which the air is discharged by centrifugal force. Some idea of this contrivance, which is very simple, may be formed by comparing it to an ordinary exhausting fan. It is the intention of the Company, now that they have obtained Parliamentary powers for opening the streets to lay down their tubes, to establish a line between St. Martin's-le-Grand and one of the district post-offices, and ultimately to extend their system throughout the metropolis, so as to connect the railway stations and public offices. Mr. F. Gye early proposed a system of this kind.—*Builder.*

NEW AIR-ENGINE.

MR. L. SIMON, of New Radford, has patented a New Air-Engine, which is thus described in the *Nottingham Daily Express.* This engine has since been used for driving some large glazing rollers, which had before been worked by steam power, and in a short time it will also be in use for drying purposes. The fire is made of coke, and in half-an-hour sufficient atmospheric air is produced in the dome and cylinder to work the engine at any speed. The heated air then escapes through some stove piping, and enters the room which, in the case of Mr. Simon, is used for drying purposes. The smoke from the fire never enters the engine, and is kept entirely separate from the air, a chimney being erected on the dome through which it passes clear away. Only a third part of the fuel that would be required for a steam-engine of the same power is used, half a hundred weight of coke being sufficient to drive a two-horse engine for twelve hours.

STEAMSHIP PERFORMANCE.

MR. ATHERTON has read to the British Association a paper entitled, "Freight, as affected by the Differences in the Dynamical Performance of Steamships." The paper showed the question of freight to be affected by no fewer than ten circumstances, the chief of these being, variation in the size of ships, variation in their construction, in their type of form, and the intended length of voyage; also in the construction of engine, in the variations of the speed of engines, and by various combinations of these. The importance of excellence in the material of construction was pointed out as being valuable in reducing the weight of the ship, without decreasing the strength. *If the speed of a steamer of certain size were increased from 10 knots to 12 knots* per hour, that would necessitate an *increase of 31 per cent. on the* cargo.

Mr. Scott Russell spoke of the importance of this paper to the city of Manchester, which was greatly affected by freight, in the import of raw materials and the export of manufactured goods. Three steamship companies had been formed, spending about 3,000,000*l.*, which had never earned an honest penny to their owners. If those owners had possessed such a table as that worked out by Mr. Atherton, they would not have fallen into such fatal errors. It was necessary that each ship should be adapted to its work. For every length of voyage there was an exact kind of steamer that would pay, and a kind of steamer that would not pay. A steamer might be calculated to make its owner a fortune if on the right station, but might ruin him if placed on another. The length of voyage, the speed to be travelled, and the probable cargo obtainable, were practical points to be kept in view. Then they might, as had been shown, throw away 30 per cent. by a wrong shape of ship. Now, shape cost nothing—it was only putting the same material into one shape instead of another, but by it they might gain or throw away 30 per cent. Very much depended upon the intended length of voyage. If they wished to steam 12,000 miles, they must have something like a 12,000-tons ship; if 24,000 miles, then 24,000 tons would be necessary. It was also important that the management of the engines should be under intelligent men. Some would rather give one man 20*l.* a month, in preference to giving another 25*l.*, although the former would burn them 600 tons more coal, consume 25*l.* worth more tallow, and cause no end of waste. Those were practical questions for Manchester ship-owners. Then they must give a good price for a good engine. There were qualities of iron which cost say 10*l.*, 20*l.*, and 30*l.* a ton. The makers of the engine had to take the same profit out of each, consequently the purchaser got the full benefit of the extra quality. That made the difference between 40 lbs. per horse-power and 60 lbs. per horse-power, and it was a lesson which had to be learnt. A man must pay a good price for a good engine, or he would not get one, whatever was promised. Then he will have to pay something for a dry condenser, so that fresh water may be used in the boiler, which will, in consequence, last much longer, and admit of higher pressure being carried, and fuel greatly economized. Mr. Johnson referred to an instance of great saving in coal, by a bonus being given to the engineers. Mr. Bailey thought Mr. S. Russell assumed the ship-owner to be less acquainted with the various points of interest to them than they really were. He had been connected with ship-building nearly 50 years, and found them generally pretty shrewd, and ready to adopt, certainly not theories, but practical improvements.

Mr. Scott Russell presented the Report of the Committee of the Association appointed to consider the question of Steam performance. He said the report was long, and contained tables and statistics of a valuable character, which of course could not be read in the ordinary way. The Report would not be intelligible without the statistics, and he therefore thought it better to state briefly to the Section the results which had been attained by the Committee during

the past year. On the previous day, in that room, a paper was read by Mr. Atherton, chief engineer of Woolwich Dockyard, which had a most important bearing on this subject. Mr. Atherton showed that, by a little variation in the shape of a ship, a difference of 32 per cent. might be obtained—that was to say, that between a properly-constructed vessel and an improperly-constructed vessel there was a difference of 32 per cent. Coming from such a quarter, this was a most important admission, because it showed that the principle for which the British Association had been contending twenty years had been at last admitted—and the very shape which the experiments instituted by the British Association had demonstrated to be the best—namely, the hollow water-line, and the form known as the wave-line was the shape now adopted by the Government in the construction of their fastest vessels. The Committee had been most anxious to ascertain for every vessel what was the value of her form as distinct from the power of her engines. He believed that the best and only way to do this was for the Admiralty to make arrangements that after every vessel was launched her screw should be taken out, and that the vessel as a mere hulk should be dragged through the water with a dynamometer attached to the towing-rope, so that the amount of resistance offered could be ascertained.

STATIONARY ENGINES.

MR. JOHNSON has read to the British Association a paper "On the Best Arrangement of Stationary Engines on the Reciprocating Principle." He said that, whilst immense improvements had been made in almost every other class of machinery, the stationary beam-engine remained almost in the same state as when it first left the hands of the maker, and was one of the most imperfect pieces of mechanism of the present day. He compared the beam-engine with the direct-action engines, which he said were superior to the beam-engine in these points—they were independent of the foundation and engine-room walls for support; they were less liable to derangement and to breakage, and when a breakage did occur, it was less serious in its results than in the beam-engine; and the condensing apparatus was easy of access. Professor Willis, who had taken the chair in the temporary absence of the President, said the points brought forward in the paper just read were well worthy the attention of mechanical men. Mr. Scott Russell thought there were many who would agree with the author in his original proposition, that to get an economical, durable, and reliable engine, it was not necessary to go back to the beam-engine. In marine engines, the beam-engines, which were long the favourites, had been given up almost universally. He believed the popularity of the beam-engine was to some extent explained by the fact that originally stonework and masonry were cheaper than iron frames, but this was no longer the case. He believed the direct-acting engine would shortly entirely supersede the side-lever engine. Mr. Hopkinson advocated the horizontal engine. Mr. Roberts said he agreed with Mr. Johnson as

to the desirability of direct-acting engines, and he agreed generally with the horizontal engines. Mr. Clay reminded Mr. Scott Russell that one of the most successful shipbuilding firms, Messrs. Robert Napier and Co., still adhered to the beam-engines; and in one of the Cunard steamers, the *Scotia*, now building in the Clyde, were introducing the ordinary beam-engines. Mr. William Smith remarked that these side-lever engines of Messrs. Napier, to which allusion had been made, were about the greatest coal-eaters, and were the greatest weight per horse-power, of any engines built.

NEW STEAM-GAUGE.

An improvement upon the ordinary Steam-Gauge has been invented by Messrs. Bailey and Co., of the Albion Works, Salford. The outward appearance of the gauge is that of the ordinary Bourdon, but the interior construction differs very widely—springs, mercury, compressed air, and all that is objectionable in existing gauges being entirely dispensed with, the substitute employed being nothing more than a simple weight. Within the circular box upon which the dial is placed, and near its centre, there is provided an axis from which a pendulous weight in the form of the segment of a circle is suspended. Whilst at rest, and not acted upon by the steam (the pressure of which is to be indicated), a cycloidal lever or projection extends in a horizontal direction over a rod which is supported upon the centre of a diaphragm, in direct communication with the steam in the boiler. Upon the pressure of the steam increasing the diaphragm is acted upon, and the connecting rod is forced upwards, acting in turn upon the cycloidal lever before referred to. The tendency of this action is naturally to raise the weight from the vertical to the horizontal position, and as a toothed wheel upon the axis from which the weight is suspended gears into another toothed wheel upon the axis which carries the pointer, the pressure of the steam upon the diaphragm can be accurately indicated upon the dial.—*Mechanics' Magazine.*

A NEW STEAMSHIP.

A New Steamship, possessing several novel features, has been projected by Mr. Thomas Silver, of Philadelphia. She is to be 600 feet long, 75 feet broad, and to draw only 16 feet water. She is to have two paddle-engines that are to be located on the sides and not in the centre, as is the case in all steamers, and each engine is to work its own independent shaft and wheel. She will also have two screw-engines, each separate and working a propeller under each quarter. The hull of this vessel is to be braced in the most thorough manner for strength; she is to be divided into fifty water-tight compartments, and be 15,000 tons burden.

REARING PLANTS BY STEAM.

Mr. D. Moore, *in his* report to the Royal Dublin Society, describes *the garden of Mr. Borsig*, at Moabit, near Berlin, where there is a

fine private collection of plants, the grand features being the amazing number of tropical aquatic plants cultivated in the open air. This is effected by supplying a winding stream which passes through the garden with a constant flow of hot water from the adjoining iron works. This stream is about 100 yards long by 20 wide. Only three years ago a single plant of *Nelumbium speciosum* was planted, which has already spread itself over a great portion of the stream; and Mr. Moore saw not fewer than 100 expanded blooms of this loveliest of flowers. At the same time there were many flowers of *Victoria regia, Nymphæa Devoniana, Nymphæ cærulea, Nymphæa dentata,* &c., altogether producing such a charming floral picture as can hardly be imagined.

LARGE STEAM-HAMMER.

MESSRS. BAIN AND WYNE, engineers, Glasgow, have finished a large Steam-hammer on the "moving cylinder" principle of the late Mr. Condie. It has been erected in one of the iron-works near Birmingham. The framing consists of two square cast-iron columns, having a clear working space of 16 feet between them, and bound together by a massive horizontal cast-iron beam. These two columns are surmounted by a pair of segmental frame pillars, which, conjoined, form a complete semi-circular arch, springing up to a height of 23 feet from the floor-line. The hammer cylinder is cast of the strongest cold blast-iron, and weighs upwards of five tons, with a fall or stroke of 6 feet. The valves are wrought by means of a small horizontal steam cylinder, to which they are connected; and the attendant has merely to touch gently the slide valve of this miniature engine to put the enormous weight in motion. This hammer, with its anvil, block, and sole-plate, weighs about eighty tons.

BRICKMAKING BY STEAM.

AT Dunston, near Newcastle, Messrs. Dixon and Corbett are manufacturing Bricks by Steam. The machine is the invention of Messrs. Clayton and Co., of the Atlas Works, London. It consists of an upright cast-iron cylinder, into which the rough clay is filled from the top. Inside the cylinder are revolving angular screw blades; which, after "pugging" the clay, force it down to the bottom. Here, by a plunger or piston, it is further forced through the moulding orifices. From these it finally exudes in a continuous stream of the requisite dimensions, and is supported upon small rollers covered with moleskin until cut into slices, in the form of bricks. This process is going on simultaneously at opposite sides of the cylinder, where two boys fork them on to palette boards, and convey them to the drying-house, without having touched them or flattened the edges. The principal advantages of this patent are said to consist in the revolving dies, or perpendicular rollers, between which the *clay exudes from the* moulding orifices; and in the clay being *stationary while it is sliced;* together, giving sharpness to the edges *of the bricks.* The machine is capable of manufacturing upwards

of 1500 bricks per hour, while 400 is the usual number formed by hand.—*Builder.*

IRON CONSTRUCTION.

THE following paper, by Mr. F. W. Sheilds, has been read to the British Association, on Iron Construction, with Remarks on the Strength of Iron Columns and Arches.

It is almost needless to expatiate on the great and rapid development which the use of ironwork has received within a few years preceding the present meeting. In bridge work, the ancient structure of masonry; in roofing, the employment of wooden framing; and in shipbuilding, the use of timber, both in the naval and mercantile marine; are being gradually superseded by a material eminently possessed of the qualities of strength, durability, and cheapness for engineering construction.

Nor are these effects confined to England alone, for the employment of British iron for such purposes has now become well nigh universal. In fact, it appears almost anomalous that iron for a bridge or other construction, manufactured in this country and conveyed abroad at considerable cost, should supersede, with economy and advantage, in Australia, India, Russia, or Spain, the material indigenous to the country, and found abundantly on the spot; and this when iron is more costly in itself than the materials of wood and stone, which it supersedes.

This apparent contradiction is explained by two causes: 1st, that iron possesses, size for size, much greater strength than any other substance in general use; and, 2ndly, that it possesses eminently the capacity of being manufactured in such variable shapes and sizes as the nature of the case may require, so that sufficient material may be supplied in each part of the structure to meet the stress or strain upon that part, without any being wasted or lost to use.

Under these circumstances, an iron construction of many parts, accurately proportioned for its purpose, should, when loaded to the point of fracture, have every part strained to the full extent of its resisting power. If some of its parts be increased in scantling beyond this proportion, such increase will add nothing to the strength of the structure as a whole, which is limited by the strength of its weakest part, and will only involve the addition of useless weight and expense to the construction.

It follows, therefore, that the designer of iron structures should possess not only the workman's practical knowledge of the material with which he has to deal, but should be peculiarly acquainted with the scientific and mechanical principles by which the strains on each part are found, so as to enable him to apportion correctly the scantlings for those parts.

The object, therefore, of this paper is to call attention to the necessity for a greater diffusion amongst practical men dealing with ironwork of the knowledge of the mode of calculating the strains upon the usual constructions to which iron is applied. Nor is economy the only consideration which urges the necessity for progress

in this respect. In a framing, where the strains are transmitted from one portion to another, throughout the structure, the insufficiency of one part may easily compromise the stability of the whole; and the element of safety enters largely into the consideration of the question in this view.

It will not be attempted in this paper to recapitulate the scientific principles in question, which the author of these remarks has recently ventured to lay briefly before the public. It is conceived, however, that it may be acceptable to state the conclusions to which experience has led him, as to the practical amount of loading which may be laid upon iron columns and arches, the result of which he has not previously made public.

Iron Columns.

The foregoing remarks have had reference to framed and other structures, of comparatively complicated character, with strains varying both in nature and in amount; but in the simple constructions now alluded to, it is believed that practice affords the best guide.

The author's professional engagements on the construction of the Crystal Palace at Sydenham and other works have given him much opportunity of ascertaining the amount of load which cast-iron columns will sustain with safety. In his practice accordingly the following rules are adopted as the basis of calculation of their strength, the columns being supposed of good construction, with flat ends and with base plates at their bearings.

For hollow columns of 20 to 24 diameters in length,—

If cast ¾-inch thick or upwards...............		Columns may be loaded with 2 tons for each square inch sectional area of columns.
Ditto ⅝-inch „ „	1¾	ditto.
Ditto ½-inch „ „	1½	ditto.
Ditto ⅜-inch „ „	1¼	ditto.

For columns of 25 to 30 diameters in length,—

If ¾-inch thick or upwards...............	1¾	ton per square inch.
Ditto ⅝-inch „ „	1½	ditto.
Ditto ½-inch „ „	1¼	ditto.
Ditto ⅜-inch „ „	1	ditto.

The cause of the modifications of loading from varying thicknesses is, that thin and light columns are more liable to fracture from inequalities of casting and from accident, and should therefore be less loaded in proportion than those of greater thickness.

Iron Arches.

In the apportionment of iron to meet the strain or thrust of an arch, it is usual amongst engineers to allow not more than 2½ tons of thrust or pressure to each sectional inch of cast-iron, and 4 tons of pressure to each sectional inch of wrought-iron.

Independently of the compression of the arch, it is advisable in very flat arches to consider the flat central portion as a girder, and to give to its top and bottom such flanges as a simple beam of its length and depth would require. Thus in an arch forming a curve of 300 feet radius, which the author had recently to design, the central portion of 70 feet was considered as an independent girder, and treated in this manner.

In bringing these brief remarks to a close, it may be stated as their object to promote a general knowledge of ruling principles in a subject of ever-growing importance.

Mr. Scott Russell thought the meaning of Mr. Sheilds' paper *was this, that taking* the very valuable experiments of Mr. Fair-

bairn and Mr. Hodgkinson, which would give say 2½ tons upon the square inch upon the breaking weight of the column, when you come to a certain degree of thinness you would have to reduce that proportion on account of the exceptional thinness of the iron, and thus, while one square inch of the iron might bear 2½ tons, in half an inch you must reduce the proportion to 1½ tons, and if you came as thin as ⅜ of an inch the column would only bear one inch to the ton. This was a valuable contribution to their statistical knowledge.

Mr. Nasmyth has drawn attention to another branch of construction—the manner in which the iron weldings are made; to the defective manipulation of which vitally important branch of iron-working so many and fatal railway accidents are to be attributed. The perfect welding of malleable iron can only be ensured by thoroughly expelling all the vitrified coating from between the surfaces where the welding takes place.—The only security is to form the surfaces of the iron at the part where the welding is to take place slightly convex, so that when applied to each other at the welding heat, their first contact shall be in the centre of each; and that when they are driven closer together by means of hammers, a free escape for the vitreous oxide may always be preserved to the last. In this way the two surfaces would always be in perfect metallic contact, and would be as strong and safe as if they were one piece of metal.

THE ASTRONOMER-ROYAL ON CHRONOMETERS.

THE following noteworthy information is extracted from the Report of the Astronomer-Royal on the trial of Chronometers for purchase.

"An examination of the rates of the chronometers leads me to the following conclusions:—

"(A.) The material and workmanship of all the chronometers is very good; and amongst nearly all the chronometers there is very little difference indeed in this respect. In uniform circumstances of temperature, every one of the chronometers would go almost as well as an astronomical clock.

"(B.) The great cause of failure is the want of compensation, or the too great compensation, for the effects of temperature.

"(C.) Another very serious cause of error is brought out clearly in this trial; namely, fault in the oil, which is injured by heat. This is very different with the chronometers of different makers. For instance: the oil used by one chronometer maker (named in the Report) is not at all injured by heat; while some of that used by another chronometer maker (also named) is so bad that, after going through the same heating as those of the first-mentioned maker, the rates of the chronometers are changed (on returning to ordinary temperature) by 80 seconds per week.

"(D.) I believe that nearly all the irregularities from week to week, *which generally* would be interpreted as proving bad workmanship, *are in reality due to* the two causes (B.) and (C.)

"G. B. AIRY, Astronomer-Royal."

MANUFACTURE OF IRON.

The best quality of Iron has hitherto been made by using charcoal, instead of which Mr. P. Woodruff, of Machen, proposes to use in the puddling-furnace as a flux peroxide of manganese, which being a chemical compound of manganese, the oxygen leaves the manganese and unites with the sulphur, phosphorus, or other matters which are combined with pig-iron; and which are noxious, and at variance with malleable iron, and the manganese combines with the iron, giving it ductility and great malleability. He charges the puddling-furnace in the usual way with 4 to 5 cwt. of pig metal, and when the iron is well melted he puts in the flux of peroxide of manganese, using from 1 to 3 lb. for each charge, the quantity being dependent upon the nature of the pig-iron used, and the quality of the iron required. The chief feature of the invention is the addition of the flux at the precise period, the results being far less satisfactory if the addition be made either at an earlier period or in the boil. Mr. Woodruff finds that by this process, with ordinary care and attention, uniformity of product will be obtained; and in making tin-plates the bar-iron will roll with great softness, and at a low degree of heat, fineness of surface, and with little mill waste, will open without trouble, and will produce but few wasters—all essential points in tin-plate manufacturing—whilst the sheets when finished are superior in appearance and toughness to any hitherto made.

COLD ROLLING IRON.

At a meeting of the Manchester Literary and Philosophical Society, Mr. Fairbairn has explained certain experiments which he has made on the process of Cold Rolling as applied to Iron. He had tested specimens of cold rolled iron manufactured both by Mr. Lauth and Earl Dudley. In the former case, a black bar from the rolls broke with 26·173 tons per square inch, a similar turned bar with 27·119 tons, and a cold rolled bar of the same iron sustained 39·388 tons. The elongations, which may be considered as the measure of ductility, were ·200 and ·220 per unit of length in the case of the ordinary iron, and ·079 in the cold rolled iron. A plate of cold rolled iron, from Earl Dudley, sustained no less than 51·3 tons per square inch. Endeavours were being made to apply the invention to railway bars. Mr. Brockbank described the Bessemer process of manufacturing iron and steel, and stated his belief that the variously coloured flames on the surface of newly run steel would afford the means of detecting the presence of metals and other bodies by the new method of spectrum analysis.—*Mechanics' Magazine.*

MANUFACTURE OF STEEL.

The ordinary process of cementation is necessarily a long and tedious one; and in order to expedite it an invention has recently been patented for Mr. A. Lemaire, of Paris. The improved process may be carried on in any ordinary cementation furnaces now used,

or apparatus specially adapted for the purpose may be employed, and these furnaces or apparatus may be heated either by the waste heat coming from other processes or operations, or furnaces may be constructed for the purpose. The invention consists in the employment in the cementation process of a mixture of pulverized carbon and carbonate of baryta or strontia, or other alkaline earthy carbonates. The apparatus, whatever may be its form, is charged with a mixture of pulverized carbon and powdered natural carbonate of baryta. A portion of the baryta may, if desired, be replaced by an equivalent quantity of the carbonate of strontia. The ends of the chambers or vessels in which the cementation takes place may then be partially closed, and the whole heated to red heat. When the temperature appears sufficiently high, one of the ends of the chamber is opened, and the bars of iron are introduced into the middle of the cementing ingredients, so that the bars may be completely covered with the mixture. When the apparatus has been filled, the openings are closed. A bar may be withdrawn from time to time, and tested in the usual manner, to ascertain how the process progresses; and when the process is considered complete, the bars are all removed from the apparatus, taking care, however, to return into the cementing chamber any of the cementing ingredients that may be drawn out with the bars, and then the chamber may be again charged with fresh bars of iron, adding from time to time a little of the cementing mixture, to compensate for what may have become lost during the previous process.

MANUFACTURE OF SHEAR-STEEL.

STEEL obtained by the process of puddling, and known as puddled steel and steel-iron, is found not to answer all the purposes to which it might be applied, for want of uniformity and homogeneity; puddled steel, as well as raw steel, is, therefore, either formed into cast-steel, or, by refining, into Shear-steel. As an improvement upon this mode of manufacturing shear-steel, Mr. Wilhelm Spielfield, of Unna, Westphalia, has patented an invention which consists in protecting puddled steel and raw steel against the action of the gas developed from the fuel, as well as against the action of atmospheric air, while the puddled or raw steel is exposed to welding heat, or the highest heat which it can stand without melting. For this purpose lumps or piles of puddled steel, or of raw steel, are placed in retorts or vessels made of fire-proof materials. He closes the opening into the retort by a lid with a sight-hole in it, and places the retort or vessel in a furnace to be heated: by preference he uses retorts of prismatic form. The lid should cover the opening into the retort as accurately as possible. The sight-hole in the lid communicates with a sight-hole in the furnace door, so that the workman can at any time watch the steel within the retorts or vessels without opening the furnace door, or removing the lid of the retort. When the steel has become properly heated, its surface presents a silver-like appearance, and the interior of the retort appears of a bluish-white

colour. The time during which the steel is kept in this state of heat must not be too short, and cannot be too long, provided the heat be not increased to such a degree as will fuse the steel. After some time, which experience will dictate, the steel is taken out of the retort and hammered and rolled, and the result is a high-quality shear-steel, applicable for cutlery, wire-plates, and other purposes. —*Mechanics' Magazine*.

PUDDLE-STEEL.

MR. E. B. MUNRO, in a letter to the *Mining Journal*, states that he has manufactured Puddle-Steel from pig-iron and wood (white pine) for the last three years in a single puddling furnace; the operation did not prove good from a double one. The average produce of one single furnace in 10 hours was 25 cwt.; the steel was produced at an advance of 23 per cent. on the price of wrought-iron. The waste never exceeded 3½ per cent., and often less, although the greater part of it was reduced to ⅝ and ½-inch squares. The steel was used for all kinds of mechanical purposes, such as taps, dies, chisels, hammers, cutters, knives, &c., in fact, answered all purposes required, and in many instances answered better than, and was preferred to, Sheffield cast-steel. Cutters have been made from the fag end of a 1½-inch billet rolled direct from the puddle bloom at the *same heat*, which have stood, working regularly for 24 hours, planing a rough casting *without* requiring to be sharpened. For all mining purposes nothing could supersede it—hammers, boring-bars, picks, sledges, &c., were made entirely of it. He found it cheaper than welding the iron and steel together for such purposes, and never found it to fail to weld with the greatest ease. In appearance before tempering, it shows a very fine silky fibre, is of great strength and elasticity, when tempered assumes the compactness, fineness, and colour of cast-steel, and requires a practical eye to detect it from the latter. The wear of the furnaces employed for its manufacture cost three-fourths less than those for puddling iron.

CAST-STEEL.

THE two following contributions have been read to the Institution of Mechanical Engineers at Sheffield:—

1. A paper by Mr. Bessemer, "On the Manufacture of Cast-steel, and its Application to Constructive Purposes." Steel, he said, had hitherto been to the engineer what granite was to the builder; and the problem was, how to produce cast-steel that would take any form in the mould, or under the hammer; that would yield quickly and readily to all cutting and shaping machines; that would retain all the toughness of iron, with much greater tensile strength; and have all the clearness of surface, beauty of finish, and durability that distinguished the harder and more refractory qualities of steel in common use. These objects Mr. Bessemer believed he had fully accomplished by his process of converting crude

molten iron into cast-steel at a single operation, which had been carried on in this town for two years. The process was then described at some length, and specimens were exhibited to show that the Bessemer steel met the desired requirements.

2. A paper by Mr. T. E. Vickers, of the firm of Naylor, Vickers, and Co., "On the Effect of the Combination of Carbon with Iron in increasing or diminishing its Strength." The paper stated that the superior strength of cast-steel cannot be better illustrated than by remarking that castings of steel without hammering, rolling, or other means of mechanical compression, show a very high degree of strength and tenacity, far above that of castings of any other kind in practical use. Advantage is taken of this property of cast-steel to make bells of that material, one-third lighter than bronze bells of the same diameter; and this lighter steel bell will still bear double the breaking strain of the bronze one. Another superiority of steel castings is that they are not as liable as other metal to break when subjected to concussions during intense frost, as proved by the fact that cast-steel bells are rung in Russia and Canada, where the thermometer ranges below 20° under zero (Fahrenheit), without the least injury, while the heavier and thicker bronze bells could not be rung in the same temperature without cracking. The same properties have led to the manufacture of cast-steel railway carriage and engine disc wheels, with tires, in one solid body.

THE WESTMINSTER BELLS.

WE find the following interesting details of these inharmonious Bells in the *Builder*:—

The Westminster clock has again begun to strike the quarters on the four quarter bells, and the hour also on the largest of them, which is rather smaller but more powerful, as well as much sweeter in tone, than the great bell of St. Paul's. It is, however, just four notes too high for the proper note to follow the quarters, being B instead of E, the octave below the third bell which finishes the chime. The quarter hammers have been lightened in order to make an apparent distinction between the striking of the hour and the quarters on the same bell. This is but a poor substitute for the proper difference of note, and the quarters sound more feeble than they did in September, 1859, before the Board of Works stopped them, on the cracks in Big Ben being discovered. A recent Parlia-liamentary return on the subject has added one more to thestartling contradictions by which men of science sometimes astonish the world. No less a person than the Astronomer-Royal reports to the Board of Works that two of these bells are a note and a half, and another of them half a note, out of tune, and proposes to recast them accordingly; while it is stated in the last edition of Mr. Denison's *Treatise on Clocks and Bells*, that all the bells were certified by Mr. Turle, and other musical authorities, as being "in perfect tune." Moreover, according to the simple mathematical rule given in various books for the size and thickness of bells, and all other vibrat-

ing bodies, any such deviation from the proper notes as Mr. Airy discovers would surely be impossible, without such an enormous deviation from the proper size or thickness as he must have observed if he had measured them. There is or was another curious contradiction in the views of the different authorities as to the great bell, which it seems is now unquestionably defunct. Mr. Denison, as he has good reason to remember, published his opinion in 1859, that it was unsound, porous, a defective casting, and cracked irretrievably in consequence of its own defects. Professor Tyndall and the Astronomer-Royal subsequently reported to the Board of Works that it was "perfectly sound for all practical purposes," the cracks only superficial, and that cutting them out, "to relieve the metal from strain," and turning the bell to strike in another place, with a lighter hammer, was all that was required; and so Mr. Cowper told the House of Commons. At last Dr. Percy is authorized to cut into the bell to the bottom of one of the cracks, which Mr. Denison complains of the Board of Works refusing either to do or allow him to do, before Mr. Mears's action came on, three months after the bell was cracked. Dr. Percy finds that the explored crack (which is not the largest externally) already goes nearly half way through the bell. He gives the analysis of numerous bits of metal from various parts and depths, and reports that "most of them are unsound and porous, the metal generally far from homogeneous, and of varying specific gravity," and "*that the casting is defective;*" and he shows that to the depth of two inches from the surface there is a considerable excess of tin beyond the amount prescribed, half of which excess, he says, would be enough to "make a sensible increase in the hardness and brittleness of the metal." He accordingly attributes the failure to these causes, which are now removed from the region of scientific speculation into the more certain realms of fact. Probably all this would have been ascertained in a week, and the bell replaced by this time with a sound one (if our "eminent bell-founders" are really able to produce such an article), if it had belonged to anybody except the nation.

WELDING IRON IN VACUO.

In a communication to the Academy of Sciences, at Paris, M. Faye, according to *Galignani*, has given the following account of some experiments, in which M. Ruhmkorff took part. An iron wire was cut in two, and the ends brought into contact without any mechanical pressure: this done, by means of an electrical current the wires were heated to a dark red *in vacuo*, and they were thus instantaneously welded together. The wires were at an angle of 150 degrees; and yet, with that inclination, they supported a weight of upwards of three kilogrammes, before breaking at the point where the welding had been effected. The same experiment, made in the open air, by way of a counter-proof, led to no result. Encouraged by this success, M. Faye heated a thick iron cylinder *in vacuo*: it had been sawed in two, and the parts then joined together by two

screws. The latter having inadvertently been made of brass, they began to melt during the heating process; but although but a very small portion of the metal had actually become fluid, it penetrated by capillary attraction, aided by the vacuum, into the smallest fissures, soldering the two pieces with extraordinary nicety.

BERTRAM'S WELDED BEAMS.

A CONSIDERABLE number of Bertram's patent Welded Beams have been employed at Deptford and Woolwich Dockyards, for fitment as deck-beams on board the various ships now building, similar to those supplied to the *Warrior*, *Black Prince*, *Resistance*, *Defence*, and other ships of the same construction. It appears now to be the decided opinion of most scientific men of the iron shipbuilding and engineering profession that most of the disasters at sea and boiler explosions occur in consequence of the inherent defectiveness of the riveting system, and the more so for ships, as the metal is more cut away, to obtain the countersink for the rivet-head, by which a smooth skin is obtained, thereby giving speed to the vessel which could not be attained if the heads projected outside. Another source of weakness in the riveting system is the attaching the water-tight bulkheads to the side of the vessel, by a row of rivet-holes in a straight line, round the ship, which perforation weakens the vessel in a similar ratio to that of the separation on the postage-stamp, thereby showing the desirability of bringing out the welding process, so that all sheet-iron structures, whether of ships, steam-boilers, &c., might be made in one entire piece.—*Times*.

EXTRAORDINARY LOCK.

THERE has been manufactured at Wolverhampton a new patent Keyless Lock, having 244,140,625 combinations. This lock is the invention of Count Kersolon, a Frenchman, but it is now the property in this country of Mr. Loysell. It has five rollers, and each roller is marked with twenty-five letters of the alphabet. If the letter at which it is set should not be discovered, the exhausting of all the variations necessary in that case to the opening of the lock would require an immense expenditure of time. It is intended to place one of these locks upon some iron safes that are being made for exhibition at the forthcoming World's Fair. In one of the safes it is proposed to place the sum of 500*l.*, which is to fall to the lot of the person who may be fortunate enough to effect an opening of the safe.—*Leeds Intelligencer*.

AIR-TIGHT COFFINS.

A COMPANY at Birmingham have embarked in a patented manufacture of Metallic Coffins, which, the report states, "seem likely to come into general use." These metallic coffins are made of sheet zinc, with a bead round the edges to impart strength to the structure. Each one, when made, is tested both as to its strength and the fact

of its being air-tight, and when the corpse is put in an attendant of the company solders on the lid. The coffin, so fastened, is hermetically sealed against the ingress of air; and medical testimony shows that the quantity of air remaining in the coffin when the lid is fastened on is not sufficient to allow decomposition to progress. These coffins are so constructed as to combine great strength and durability with comparatively little weight. A metallic coffin, of the most solid and secure make, costs no more than a very ordinary one of wood, which cannot be made to exclude the air. Apart from the commercial advantages of the invention, it recommends itself very strongly on sanitary grounds, and has been approved by numerous medical practitioners, and other gentlemen in the Company's locality who are competent to judge of its merits. If persons die of infectious diseases, or if from other reasons it is advisable that a corpse should be sealed up from atmospheric action as soon as possible, these coffins can be supplied at a very few hours' notice, even when they have to be manufactured to meet special cases; and if it is required to preserve a view of the features for relatives or friends who do not arrive until after death has taken place, a coffin can be used with a glass plate inserted in the lid, revealing the face, from which, as from the rest of the body, the ravages of decomposition are kept away by the exclusion of air.—*Aris's Birmingham Gazette.*

GOLD-PRODUCING MACHINERY.

A RETURN laid before the Parliament at Melbourne by the Minister of Mines shows the rapid progress made to the 31st of December last, in applying Steam and Machinery to the Production of Gold in that colony. It shows that on the 31st of December, 1860, there were 107,572 adult miners—viz., 60,874 Europeans and 28,100 Chinese engaged in alluvial workings, and 18,570 Europeans and 28 Chinese engaged in quartz-mining. The number of steam-engines employed in alluvial workings for winding, pumping. puddling, &c., was 294, amounting to 4137 horse-power. Besides steam-engines there were 3957 horse-puddling machines, 354 horse whims, 128 water-wheels, and 56 horse-pumps. In addition to these there were engaged in quartz-mining and crushing 420 steam-engines, equal to 6696 horse-power, 158 whims, 6 water-wheels, 26 whips, and 40 horse-crushing machines. The approximate value of all this mining plant is set down at 1,259,660*l.*, and there are in the principal towns in the mining districts manufactories of engines and machinery that compete successfully with those imported from England. Great as is the progress shown by these figures in giving a character of permanency to the supply of gold, it is now probable that the colony is about to enter on a still greater development of this source of wealth, the alluvial diggers having hitherto been kept idle for a large portion of the year by the want of water. Government are forming large reservoirs for collecting and storing rain on the various diggings, and quartz-mining is likely to receive an immense impetus from the many experiments being made and

patents claimed for improved methods of extracting the finer particles of gold from the *débris*, or tailings of quartz that have passed through the ordinary process of crushing, washing, and amalgamating.

Among those thus employed is Mr. Porter, of Italian Gully, near Ballarat, who being engaged in quartz-crushing, announces that he has discovered that by placing 76 lb. of quicksilver in the bottom of a retort, and then putting into it 225 lb. of tailings, and placing the retort on the furnace until the quicksilver is vapourized, it is by this means brought into contact with all, even the most minute particles, while the loss of quicksilver has been only 6 oz. out of the 76 lb. placed in the retort. The result alleged to have been obtained in these comparatively small experiments is, it is remarked, "so great, that, if the same can be obtained on tons as is announced on cwts., it will be difficult to give an approximate estimate of the extent to which the production of gold will be carried in Victoria; for the great bulk of the colony, from Ballarat to Twofold Bay, and from the banks of the Murray and Ovens Rivers to the parallel of Melbourne, is one great goldfield of more or less richness." The immediate consequence at present is that quicksilver is all bought up at 2s. 1½d. to 2s. 6d., and is now held for 3s. to 3s. 6d.—*Mechanics' Magazine.*

GILDING PORCELAIN.

PORCELAIN is now ornamented with Gold, in Paris, by hydrofluoric acid and electroplating, as follows:—The porcelain is first covered with a varnish, upon which the drawing is made with a fine point. The subject is then eaten out by the acid vapours, and the vessels afterwards plunged into silver or gold baths, when a deposit of these metals is determined, in the parts corroded by the acid, by means of galvanism. In some cases, certain coloured mineral powders are rubbed into the tracings left by the hydrofluoric acid, and fixed there by the action of heat, so that any design can thus be produced.

PIERCING HOLES IN GLASS.

THE Piercing of Glass by Electrical Sparks is no novelty, but there has been hitherto no instance of such an operation being performed on a plate of glass two inches thick and upwards. The Paris Academy of Sciences was therefore somewhat surprised when M. Faye produced two plates, or rather lumps of glass, one of the thickness of 4½ centimètres, the other of 6, pierced through and through by the induction spark of Ruhmkorff's large machine. M. Faye observed that the trace left by the spark consisted of an opaque white thread, along which cracks, two or three millimètres in length, were perceived spirally situate under different azimuths. There was no trace of fusion. During the experiment, Haidinger's coloured tassels were noticed, showing that a *powerful pressure was being* exercised by the spark on the surface of *the glass.—Builder.*

SUBAQUEOUS WORK.

A LORGNETTE for Subaqueous Exploration has been prepared by Dr. C. M. Cresson, of Philadelphia. Its peculiarity consists in placing a Nicol's prism of Iceland spar between the object-glass and the eyepiece, which removes the greater part of the bright light reflected from the surface of water, and thus renders objects beneath water more distinctly visible.

PYRONOME: A NEW PRODUCT TO SUPERSEDE GUNPOWDER FOR BLASTING IN MINES OR QUARRIES.

THE loss of life from the careless use of gunpowder in mining is so great, that our readers will be glad to learn of a new product, less liable to explosion from careless treatment, and much cheaper than gunpowder, for blasting rocks, &c., and which, after having been exposed to damp or wet, does not lose its explosive power, but becomes serviceable again after being dried.

This substance has been invented by a Mr. Reynaud, who has named it Pyrenome. As compared with gunpowder, it is much lighter, and produces the same effect. Its cost price is considerably less than gunpowder, but it cannot be advantageously used for fire-arms. It is composed of—

	Parts
Nitrate of soda	52·5
Residue of tan (after it has been used for tanning) ...	27·5
Powdered sulphur	20·0
	100·0

The operations for its preparation are as follows:—

1st. Dissolve the nitrate of soda in a sufficient quantity of water.

2nd. Mix the tan in this solution in such a manner that all parts may become impregnated.

3rd. Mix the powdered sulphur in the same manner.

4th. Take the product from the fire and dry it. When completely desiccated, it may be placed in sacks or barrels for use.

This product is much superior for the uses above named to gunpowder in every respect, and will, we doubt not, be received as a boon by both miner and mine proprietor, and will come into general use. Arranged in cartridges, no possible accident could happen, and, besides being 15 per cent. cheaper than gunpowder, it possesses the rare quality of retaining its explosive properties after being subjected to damp or wet—merely requiring drying—and its preparation is so exceedingly easy as to bring it within the means of every one to manufacture for himself.—*Mechanics' Magazine.*

THE BREAKWATER AT PORTLAND.

THE Breakwater at Portland is finished, and the *Times* has given a warmly-coloured account of the success which has been achieved. The writer says, the shape of the breakwater is an obtuse angle,

stretching from the island at first towards the north-east, and then turning away due north into deep water, half across the splendid bay. Apparently, as one stands on the shore and looks along the interminable rows of black timbers peering up starkly out of the sharp long reef of white stones, there does not seem a great deal to show for nearly thirteen years of constant labour, for the fruits of all this toil are, of course, beneath the sea. If the restless waves were away, the visitor would behold a sort of ridgy mountain, or, at least, a hill of colossal stones, more than a mile and a half long, 100 feet high, and 300 wide at its base. More than 5,000,000 tons of stone have already been used, and at the least 1,000,000 or 1,500,000 more will yet be required. The harbour thus sheltered, and almost enclosed, by this stupendous sea-wall has a total extent at low water of 2107 acres. At 2 fathoms deep and upwards there are 1750 acres, at 3 fathoms 1590, and no less than 1290 acres varying from 5 to 11 fathoms in depth. Taking 3 fathoms as the standard at low water, the acreage of our made harbours is as follows:—Kingston, 140 acres; Holyhead, 267; Dover (when made), 374; Portland, 1290; and Plymouth, 1741. The average of very deep sheltered water is, however, greater at Portland than at Plymouth. Just before the curve of the angle in the work there is an opening in the breakwater of 400 feet wide, which separates its eastern from its great northern length. This opening is made in order that ships going out in a northerly wind may not have to beat up the whole length of the breakwater, but pass through the aperture with a fair wind and get at once to sea.

The length of this eastern part of the work from the land to the opening is 1900 feet, and the length of the northern breakwater beyond is a little over 6000. The eastern portion, as we have said, is quite finished, and faced with granite at its parapet. The top, or promenade, if we may so call it, along this is divided into two broad platforms. That on the inner side is about 40 feet broad, and 12 above the sea. The platform or terrace above this is supported on a series of arches, and is about 18 feet broad and 28 feet above the sea. All the stone used in the breakwater, except the granite facings and parapets, which are from Cornwall, has been obtained from the Portland quarries, and three-fourths of it have been excavated by the labour of the convicts at the immense prison on the island. The quarries are situate some 400 or 500 feet above the level of the breakwater, to which it is conveyed down by 3 inclines of broad gauge double rails. These inclines are each about 1500 feet long, with a gradient on two inclines of 1 in 10, and in the third of about 1 in 15. They are worked with a wire rope over a drum, the weight of the descending trucks full of stone winding up the train of empty waggons on the other line of rails. Thus, there is a constant succession of loaded waggons coming down the down line of each incline, with an equal stream of empty waggons being pulled up the up line, to be filled again. As fast as the full waggons arrive at the head of the breakwater, they are pushed along the tramway over the piling by a powerful locomotive to the end of the

work, when the contents of each waggon are "tipped" over into the sea. As many as 3000 tons a day have been thus "tipped in" at Portland. The tipping in is now going on very slowly, for the foundations for the north fort, at the end of the breakwater, are being commenced. The base of this will be formed by a gigantic pile of stones some 600 or 700 feet in diameter, and 30 or 40 feet high. The estimated cost of the whole breakwater is 1,047,125*l*. 928,000*l*. have been spent.

THE TUNNEL THROUGH MONT CENIS.

A LETTER in the *Patrie* describes the progress of this great work. The cutting of the Tunnel advances day and night with a regularity which excites the admiration of engineers. At the commencement of this great enterprise only the pickaxe and blasting were employed, but since the machines invented by MM. Grattone and Sommellier were brought into use, the cutting of the rock has been carried on with remarkable celerity. The machines, which are worked by compressed air, are very ingenious; they are each of 250 horse-power, and act simultaneously on both sides of the mountain. They set in motion different instruments of great power, which operate in any direction that may be required. The section of the tunnel is about 60 mètres, and when the cutting was commenced, only 12 men could, from the limited space, be occupied at each end, the work they did being only 40 centimètres (about 16 inches) per day; but the machines employ a force equal to 2500 men, and cut out daily 2 mètres—that is, 1 at each end. In a few months arrangements will be made for making the men employed relieve each other every 8 hours, and an electric light will be established, and then the extraction of rock will be 3 mètres per day. The tunnel will be 12 kilomètres (7½ miles in length). It is 1330 mètres above the level of the sea, and 1060 below the summit of Mont Cenis. It will gradually rise ½ per 1000 to the centre, descending from that point towards Piedmont on the other. In the centre of the way a small canal has been formed for carrying off the waters which filter through the rock. Every fortnight an examination is made for the purpose of ascertaining the direction of the tunnel and level of the roadway, instruments of great precision being employed in the operation. Thus far the cutting on both sides of the mountain has been found to coincide exactly. The rock is easily penetrated by the machines. When holes of from 40 to 60 centimètres (16 to 23 inches) have been bored, they are filled with gunpowder, the workmen retire to a distance of about 100 mètres, and strong doors in iron are closed to prevent fragments of the rock from flying out. Then the mine is fired, and masses of rock are heard to strike against the doors. Afterwards a current of compressed air is driven into the tunnel to expel the smoke, so as to allow the workmen to enter. The removing of the fragments of rock is effected in the way employed on the cuttings of railways, and the machines are again set in motion.—*Mechanics' Magazine.*

THE LONDON MAIN DRAINAGE WORKS.

A GENERAL examination of the Works in progress has been made by the Metropolitan Board of Works and members of the various vestries invited for the occasion. Mr. Bazalgette, the engineer, reports that—

The Northern High Level Sewer, which extends for a length of 9 miles, from Hampstead to the river Lee, at Bow, varying from 4 feet in diameter to 9½ feet by 12 feet, forms a substitute for the open Hackney-brook and Fleet sewers. This section of the work is now completed, and the penstock-chamber, tide flaps, and overflow channel at the junction of the High Level, the Middle Level, and the Outfall Sewers are works of magnitude and interest.

At the river Lee the abutment of the aqueduct on the west side is completed, and the brickwork of the eastern abutment and towing-path wall is rapidly progressing within the coffer-dams, and will soon be ready to receive the iron superstructure. The Middle Level Sewer Contract, under Messrs. Brassey, extends from Kensal-green to the penstock-chamber at Old Ford, Bow. The main line and branches are 12¼ miles in length, varying in size from 4 feet by 2 feet 6 inches to 12 feet by 9 feet in diameter. This work is now in full operation at Old Ford and in the Bayswater-road, and it is now being tunnelled under Oxford-street. Arrangements are being made with the contractors to prevent, as far as possible, inconvenience to the important thoroughfares through which it passes, and particularly during the season of the Exhibition of next year. The total value of the work executed under this contract is 63,000*l*., and the work is of good quality. The Ranelagh Storm Overflow, across Hyde-park and Kensington-gardens is drawing near to completion, although much delay has occurred in the tunnelling, from bad ground and other difficulties, and the value of the work executed is 22,000*l*. Another section of the main drainage has been satisfactorily completed at Acton, to the value of about 9820*l*. This work forms a portion of the drainage not included in the main scheme, but is provided for by a separate arrangement, and this comparatively small portion has been designated the Western Division.

The Southern High Level Sewer embraces two lines, the one falling from Clapham to New-cross, and the other from Dulwich to New.cross, whence they have been constructed side by side in one trench, but at different levels, under the Brighton, North Kent, and North Woolwich Railways, and along the New-cross-road to the Broadway, Deptford.

At Deptford-creek they discharge their storm-waters through two sewers, each 11 feet in diameter, and the sewage will be conveyed by four lines of iron pipes, under the creek, into the Outfall Sewer by gravitation. These two sewers will occupy the whole width of Church-street, from house to house, and it is necessary, therefore, to underpin and deepen the foundations of all the houses in that street, which operation is now in a forward state. Between six and seven miles of sewers are completed under this contract, at an expenditure of 118,000*l*. A short section of the Southern Low Level Sewer, under the Surrey Consumers' Gasworks at Deptford, has been constructed under great difficulties, the subsoil having turned out to be a running sand, filled with an unprecedented volume of water; but the experience gained in surmounting these difficulties has been of the utmost importance in preparing drawings and contract for the foundations of the Deptford pumping station. The Southern Outfall Sewer will convey the sewage to a pumping station at Erith marshes. Of this work about five miles have been completed, at an expenditure of about 206,000*l*. Messrs. Aird have made good progress at the Deptford pumping station, and the works are proceeding in a businesslike manner. The coffer-dam for the Low Level Sewer is completed for the first half of the work across the creek: a considerable length of iron pipes for conveying the High Level sewage are laid: the foundations of the engine-houses have been excavated, and concrete got in. Messrs. Slaughter and Gruning have prepared a large portion of the engines and pumping machinery, which are ready for delivery, and only await the advancement of the building to receive them. Up to the present time nearly one million has been expended upon the works, purchase of land, and incidentals; and there are now about 6000 workmen actively engaged upon the works, in addition to those employed in brickmaking, quarrymen, iron-founders, and other trades in various parts of England, which would probably swell the number to about 10,000. It may fairly be expected that the main intercepting scheme will be completed in about two years from the present time.

GUTTA PERCHA FLOATING BRIDGE.

Mr. JOHN RYDER has submitted to the American Government a Gutta Percha Floating Bridge, which, it is claimed, will be of great benefit to an army when a river has to be crossed and no standing bridges are near. The forward part of the bridge, it is said, can be formed into a barricade in a few minutes' time, and be perfectly bullet-proof. The structure is divided into sections 20 feet long by 20 inches in diameter; each section being supplied with a large air-chamber to be inflated with air, and which the inventor asserts will sustain 2200 lbs. The chamber is similar to a clipper ship's bottom. The sections are united by lacing with hemp rope, the eyelet-holes being about 6 inches apart. Over the sections, plank, if necessary, can be laid down; the space between each section being sufficiently wide for men, horses, and artillery to pass without the slightest inconvenience. Any number of sections can be used at once, and very little time is consumed in putting them together. The barricade referred to is formed by drawing up the leading sections with guy lines, behind which the soldiers can work their guns to a good advantage.—*Scientific American.*

THE ARTESIAN WELL AT PASSY.

ON this subject M. Dumas has read an interesting paper to the Paris Academy of Sciences, in which he gave a history of the undertaking and of the difficulties with which the engineer, M. Kind, has had to contend. The idea of boring this well originated with the necessity of providing pure and wholesome water for the population of Paris, which in a short time had increased from 1,200,000 souls to 1,700,000, thus materially augmenting the causes of infection to which the waters of the Seine are necessarily subject. Paris rests upon a stratum of chalk about 500 mètres in depth, covered with about 50 mètres of various strata of tertiary soil, and itself resting on nearly 50 mètres of marl or clay, which is in contact with the green sands from which the well of Grenelle derives its supply. The successful boring of the latter had established the fact that the water which these sands received from localities at a distance from Paris might be made to rise to the surface, and even to 30 or 40 mètres above. But the experiment had only been tried for bores not exceeding a diameter of from 20 to 30 centimètres, yielding a supply of from 2000 to 4000 cubic mètres of water per day. M. Kind came forward with an offer to bore a well of a diameter of 60 centimètres, yielding 13,300 cubic mètres at an altitude of 25 mètres above the highest point of the Bois de Boulogne. Though limiting his promises to the yield above stated, he declared his conviction that it would reach 39,600 mètres, an assertion which most engineers considered exaggerated, deeming it highly improbable that an increase in the diameter would increase the supply.

On the 23rd of December, 1854, the works were resolved on, and *the spot chosen in the neigh*bourhood of the Bois de Boulogne, where *the high temperature* of the expected column of water might be

turned to account. But the enterprise was fraught with difficulties which it required the unflinching perseverance of M. Kind to overcome; although out of the 587½ mètres which constitute the depth of the new well, there were scarcely 30 offering any serious obstacle, and these were situated in the clay either above or below the chalk stratum.

On March 31, 1857, the bore had already reached 528 mètres, and water was hourly expected, when suddenly the tube of sheet iron which supported the clay was crushed by its pressure at a depth of only 30 mètres from the top. This accident it took nearly three years to repair; a shaft of the depth of 53½ mètres had to be dug close to the bore, through all the most dangerous strata, and lined partly with sheet, and partly with cast-iron and masonry. Its diameter was three mètres throughout the two-thirds of its depth, and 1·70 for the rest. It was a work of extreme difficulty. Cast-iron tubes, of the thickness of 35 millimètres (four-fifths of an inch), were starred or cracked in all directions, as if they were mere glass. More than once the workmen refused to risk their lives in this work, and the city engineers had to set the example of personal courage.

This stupendous labour was not brought to an end before the 13th of December, 1859. The old orifice was then cleared, and the boring recommenced, and continued without any further accident to the depth of 550 mètres, when the tube, composed of wood strongly hooped with iron, and ending in a bronze pipe, two mètres of which were fitted into the wood, the remaining 12 mètres being free, stuck fast in such a way as to render all further progress nearly hopeless. However, M. Elie de Beaumont having, upon a mature examination of the specimens brought up by the borer, declared water to be close at hand, it was resolved that the bore should be continued with a small diameter, to be afterwards enlarged, if necessary. Water was found for the first time at 577½ mètres, but, as we know, remained a few mètres below the level of the orifice. A second tube, of sheet iron 70 centimètres in diameter, 2 in thickness, and 52 mètres in length, 12 of which were loopholed in order to let the water pass, was sunk, and soon stopped in the clay. The boring was now resumed, to attain the largest diameter, until the 24th of September last, when M. Kind saw not only his promise fulfilled, but even his hopes to a certain extent realized. The bronze tube has remained where it was, but the concentric one of sheet iron has sunk to 380 mètres. M. Dumas here quotes M. Michal, Inspector-General of the Works of the City, who has arranged in a table the relative variations experienced in the yield of the two wells of Passy and Grenelle; but on this score we have a later account, stating that the decrease in the latter does not exceed one-fourth of its prior yield. That of the well at Passy was 20,000 cubic mètres in 24 hours. M. Dumas attributes the diminution of the yield at Grenelle to a diminution of pressure, and is inclined to believe that when the tube at Passy shall have been brought to its normal altitude of 78 mètres above the level of the sea the yield at Grenelle will again rise to its former figure, or nearly so. M. Elie de Beaumont

has ascertained that the strata traversed at Passy are nearly the same as those met with at Grenelle. As to the chemical nature of the water at Passy, it seems, until further analysis, to be nearly the same as that of Grenelle; the temperature is also the same,—viz., 28 degrees centigrade. Whether other wells may be bored elsewhere in Paris without injury to the two existing ones is a questions which experience alone cau decide. The well at Passy has cost nearly 1,000,000f., and will yield water sufficient for the wants of 500,000 inhabitants.—*Abridged from the Times.*

ARTESIAN WELLS IN ALGERIA.

THE following are the results of Artesian borings undertaken since the year 1856, in the south of the province of Constantine:—The number of wells sunk up to the present time in the Oued-Hir, and in the Hodna, is 31, yielding 33,631 litres of water per minute. The Tougourt artesian wells, in number 19, give 2700 litres per minute: that is, for the 50 wells of the province of Constantine, a supply of 36,421 litres per minute, or, in 24 hours, 52,446,249 litres. All these borings were executed with only three sets of tools. The average depth of the Oued-Hir and Hodna perforations is 89 mètres 55 centimes; and the Tougourt has a depth of about 56 mètres 19 centimes. The mean discharge of the 31 wells of the first of these districts is 1084·89 litres per minute. For each of the 19 wells of the second district, the mean supply was 146·84 per minute. The cost of these undertakings amounted, during four years (1857, 1858, 1859, and 1860), to the sum of 262,676 francs 14 centimes, from which is to be subtracted the value of the boring apparatus, 120,000 francs: that leaves a total expenditure of 142,676 francs. The mean cost of each of the 50 wells is therefore 2853 francs 52 centimes.—*Builder.*

ARTESIAN WELLS AT PARIS.

A COMMUNICATION has been received on this subject by the Par's Academy of Sciences from M. Gaudin, in which he replies to the question, often asked, whether the supply of the Artesian wells, bored in the neighbourhood of Paris, can ever be exhausted? The stratum of green sandstone interposed between the strata of chalk and Jurassic limestone is of the average thickness of 50 mètres; consequently, taking the depth of 577 mètres of the Artesian well at Passy as a criterion, there remains a depth of 25 mètres of sand. A cubic mètre of sand, closely rammed, weighs 1600 kilogrammes, while compact quartz weighs 2500 kilogrammes; hence the stratum of sand, even supposing it to be closely packed, has interstices amounting to one-third of its bulk in the aggregate, so that every cubic mètre of sand under water contains 333 litres of water. Now, the layer of sand existing under the chalk may be represented by a disk of 160 kilomètres' radius, its surface amounting to 80,000 square millimètres, and its thickness to 8 mètres. The cubic contents of this disk are, therefore, 640,000,000,000 mètres, which,

divided by 10,000,000, then by 365, gives the quotient 175, being the number of years requisite to exhaust the supply of water at the rate of 10,000,000 cubic mètres per day! This would be correct, supposing the quantity of water to remain stationary, and never to receive any increment by the infiltration of rain-water and that of rivers. This our author calculates at half a mètre per annum, and thence arrives at the conclusion that the annual increase of the water is double the quantity expended, so that the Artesian wells in or about Paris are, and must ever be, inexhaustible.

IMPROVEMENT OF THE THAMES.

We are happy to report, upon official authority, the improvement of the state of this much-abused river.

In his last Quarterly Report (1861,) Dr. Letheby writes as follows:—"In the course of the quarter the temperature of the river has fallen from 54° to 37°, and during the whole of the time the water has been free from putrefactive decomposition. Indeed, the state of the Thames as regards its freedom from organic impurities has been remarkable. Ever since the middle of September the water, even at high tide at London-bridge, has been fit for domestic purposes. In the first week of October the total amount of soluble matter in it was but 19 grains per gallon, and for the last month it has ranged from only 21 to 22 grains, of which about two grains have been organic. The significance of this will be manifest when the quality of the water is compared with that supplied by public companies. Those whose sources are the Thames above Richmond have supplied water containing a little more than 20 grains of soluble matter per gallon, of which about a grain and a half have been organic; and those companies who receive their supply from other sources have furnished water which contains from 20 to 24 grains of soluble matter per gallon, of which from 1 to 3 were organic. This wholesome condition of the river has been brought about by the copious rainfall of the season, which has kept up a constant influx of fresh water. The consequence of this has been, not merely the dilution of the sewage which flows into the river, and the ready oxydation of organic matter, but also the keeping back of the oceanic current, which is so largely charged with saline and organic impurity. The present state of the river gives us, therefore, some notion of what its condition might be if the two great sources of impurity—the sewage and the sea—were kept out of it. It even shows us how far, under the present condition of things, its wholesomeness might be maintained if we could secure a continuous supply of fresh water."

WATER-SUPPLY, BARBADOES.

Mr. J. W. Clarke, engineer, writes from Bridgetown, Barbadoes, stating that the Waterworks Company have fixed hydrants at about fifty yards of distance from each other in all the streets and alleys of the town, the number actually fixed being 460. Bridgetown has suffered so severely and so frequently by fire that the Company

sought to make the means of future protection as ample as possible. The works were completed on the 1st of June (the water having been introduced some weeks before), in little more than twelve months after the first pipe was laid. The water is brought from a distance of fourteen miles to a covered service reservoir of 1,000,000 gallons, and distributed by about eighteen miles of mains and service pipes to the city. The service is constant high pressure by gravitation, and jets from the hydrants rise eighty feet.

There are 105 standposts in the streets, from which the inhabitants may take water for domestic use without charge, the Legislature paying the company 5000*l.* a year for this service. The poorer inhabitants derive great benefit from this supply.

The cost of construction is about 70,000*l.*, of which more than 50,000*l.* was raised on the island.

The Company, having a quantity of water in excess of the wants of the town, are seeking to extend a supply to the suburbs.

A NEW SURVEYING CHAIN.

AMONG the articles at the Wisconsin State Fair, U.S., was a new invention by Wm. H. Payne, of Sheboygan, to supersede the usual Chain used in surveying. It consists of a steel measure, which coils up like a tape measure, but is so tempered as to be perfectly straight when uncoiled. The whole weight of the instrument does not exceed three pounds. A thermometer is attached to it, and the measure, it is stated, can always be of the same length, no matter what is the temperature.

THE HYDRAULIC PRESS.

MR. EDWARD T. BELHOUSE has read to the British Association a paper, illustrated with numerous diagrams and models, "On the Applications of the Hydraulic Press," in which he traced the history of the hydraulic press from the first patent granted in the year 1785 to Mr. Joseph Bramah for his hydrostatic press down to the present day; and described its various uses and applications, entering into a minute description of various parts containing more or less of novelty either in application or design. He mentioned, in conclusion, that there were many portions of the presses which required the attention of scientific men. One of these points was that many of the presses were sent abroad to places where facilities for transport were few, and there the weight of metal was a great disadvantage. He trusted Mr. Bessemer, or some other scientific man, would bestow attention on the subject.

Mr. Bessemer said he believed cast-iron, without that quantity of carbon found in the metal usually known as cast-iron, would be eventually used. Experiments were being made, and castings had been effected, though a size large enough to be used in hydraulic presses had not yet been obtained. Mr. Oldham mentioned that in oil mills the hydraulic presses were worked with oil instead of water, and this plan of course very considerably diminished the wear and tear of *the machinery*. Mr. R. Roberts drew attention to the mode

practised by the Italians in manufacturing lead pipes by hydraulic machinery. The lead was used cold instead of hot, and when one piece was nearly done, another piece was put into the tube, so that they could produce a pipe of any length.

EXHAUSTION OF CESSPOOLS BY ATMOSPHERIC PRESSURE.

THE catacomb excavations on which Paris stands must ever prevent the adoption of a drainage system equally complete with our own. Cesspool reservoirs are there a necessity; hence some unexceptionable means of removing their contents is indispensable to salubrity. A very curious appliance to this end has been for some time employed at Milan and Turin with complete success. The process which we will presently describe is the invention of M. Chapuzot. Its operation depends on what would ordinarily be termed atmospheric suction, but more correctly expressed by atmospheric pressure. Let the reader imagine to himself a cart having an air-tight body, in which a vacuum has been created. Evidently if such an air-tight vessel be wheeled over a reservoir, and a communication established between its interior and the inside of the reservoir, by means of a tube and stop-cock, the contents of the pit (if not too deep) will rush up so soon as the cock is turned. This is the arrangement of M. Chapuzot; and at Turin and Milan, where it has been some time in use, the success of it is said to be complete. At Paris, an experimental trial of this agency has been made.—*Mechanics' Magazine.*

THE HEALTHFULNESS OF FRESH PAINT IN APARTMENTS.

M. LECLERC, a well-known house-painter in Paris, has made several experiments to ascertain whether emanations from certain paints containing such substances as white lead, zinc white, linseed oil, essence of turpentine, coal oil, essence of lavender, &c., are injurious to health. He caused the insides of some boxes to be painted, and within them he placed wire cages containing rabbits, which were not in contact with the paint, but only subject to the influence of the emanations from it. The rabbits suffered while the paint was fresh, especially when it contained coal oil, but none of them died. It is thus proved that living in apartments recently painted, and which emit the odour of the oil of turpentine, is not permanently injurious to health. M. Leclerc made, also, some other experiments for the purpose of obtaining deposits of these emanations from the fresh paintings of houses. Instead of rabbits he placed plates containing a small quantity of water in these chests. After the water had evaporated from the plates he found some remarkable crystallizations like needles, which consisted of combinations in which the oils or essences employed formed the principal part. These crystalline combinations were obtained even when linseed oil was used. M. Deville had previously obtained similar crystallizations, but under entirely different circumstances. After these experiments and their results had been explained to the

Academy of Sciences, M. Chevreul added, that M. Leclerc had opened a new path of discovery for scientific men, which even chemists might follow with profit.—*Mechanics' Magazine.*

SEWER DEODORIZATION BY CHARCOAL FILTERS.

A PAPER on this important subject was not long since read at the Society of Arts, by Professor Stenhouse, F.R.S., who may be said to have at least matured the idea; although, in his account of those who had previously investigated the subject, he should have named Mr. Jasper Rogers as a precursor, if not the original inventor of Deodorization of Foul Gases by Means of Charcoal.

The following is condensed from Dr. Stenhouse's interesting paper, which is printed in the *Journal of the Society of Arts* for 14th June, 1861:—

Towards the close of 1853, my attention was first directed to the deodorizing and disinfecting properties of charcoal; and I was not long in discovering that the views which had been previously entertained regarding the action of charcoal were exceedingly erroneous: for, instead of acting as an antiseptic, and thereby retarding the decay of putrefying substances with which it was in contact, as had been previously supposed, its action was the very reverse of this. Charcoal, therefore, from the considerable amount of condensed oxygen contained within its pores, amounting to between nine and ten volumes [and which, it might have been added, appears to be continually renewed of itself, unless the pores be allowed to be filled with water,—or the charcoal, in other words, to become wet], not only absorbs, but rapidly oxidizes the effluvia and miasmata emitted by decaying substances, and resolves them into the simplest combinations they are capable of forming.

All porous substances, such as platinum black, pumice stone, &c., possess the power of condensing gas within their pores.

The charcoal air-filter consists of a layer of charcoal in coarse powder; varying in size, according to circumstances, between a small bean and a filbert. The charcoal is placed between two sheets of wire gauze fixed in a frame, and can be readily applied to buildings, to ships, to the air-shafts of sewers, to water-closets, to respirators, and various other purposes. All the impurities in the air are absorbed by the charcoal; so that a current of pure air alone passes through the filter; and in this way pure air may be obtained from exceedingly impure sources. It is plain that perforated zinc, or a framework of coarse wire filled with larger pieces, and a greater thickness of charcoal, may be also employed, whenever the amount of effluvia evolved is very considerable.

Before the close of the year 1854, air-filters or charcoal ventilators were fitted up, both at the Mansion House and Guildhall. They are each of them several feet in diameter, the layer of charcoal being about 1½ inch in thickness. Although six years have elapsed the charcoal has never required to be renewed, owing to its oxidating power being practically unlimited. Air-filters were soon afterwards largely employed in private houses, in connexion with drains and water-closets particularly; and they were also very successfully applied to the construction of respirators, many thousands of which have ever since been annually manufactured.

Mr. Rawlinson, during the last four years, has applied charcoal air-filters to the ventilation of sewers on a large scale, at West Ham, near London; at Swansea, Worksop, and other places. The efficiency of the charcoal appears never to diminish, if it is kept dry and its pores are not choked up by dust.

The expense of applying charcoal to the disinfection of the sewers is by no means considerable, as the first outlay is all that is required. The only precautions to be observed are, that while the filters shall be sheltered from rain and moisture free access shall be given to the air.

In conclusion I may state, that for the last six years I have strongly recommended that charcoal *air-filters should* be applied to all house-drains, sinks, and *water-closets.*

Every water-closet, in my opinion, ought to be furnished with a subsidiary pipe branching off from the main pipe, a little below the valve of the closet. This subsidiary pipe should be carried a few feet above the seat of the closet; and its extremity,—which should be open, with the exception of a few wires stretched across it, merely to prevent the charcoal falling into it,—should terminate in a charcoal filter 6 or 8 inches thick, into which it should penetrate to the depth of two or three inches, so as, in fact, to be enclosed by a good body of charcoal. Under such an arrangement as this, no foul gases can penetrate into the closet.

From the preceding statements, it is plain that the oxygen contained in the air of the atmosphere is by far the cheapest and most effective deodorizing and disinfecting agent with which we are acquainted, and that the usefulness of the charcoal air-filter consists in its affording a safe and advantageous means of applying atmospheric air to disinfecting purposes.

I think it but justice to myself to state that I have no pecuniary interest in the charcoal air-filter. Though strongly urged to do so, I refrained from securing it by patent, on the ground that inventions for the prevention of disease and death ought to be sold at the lowest possible price; and should not, therefore, be encumbered with the expense and restrictions attendant upon patent rights.

Dr. Letheby, Mr. Haywood, and Mr. Rawlinson have all recently expressed to Dr. Stenhouse their continued confidence in the deodorizing powers of charcoal filters.—*Builder.*

HEATING AND VENTILATING.

At a meeting of the Metropolitan Association of Medical Officers of Health, Mr. W. Weatherby Phipson, C.E. has read a paper entitled "Notice on Dr. Van Hecke's System of Warming and Ventilation."

The author, comparing the Van Hecke system with those already employed, arrives at the conclusion, already formulated by Dr. Pettanköfer, of Berlin, and Drs. Maximillien Vernois and Grassi, of Paris, that Dr. Van Hecke's system of warming and ventilation is the only one which realizes efficient ventilation and uniform warming, with economy in outlay and in maintenance.

"The system Van Hecke," says Dr. Pettanköfer, in his recently-published remarks on warming and ventilation, "has completely upset all our ventilation traditions."

Mr. Phipson shows that this result has been attained by the application of scientific principles and mathematical calculations, by means of which the supply of air and the heat are completely under control. The author explained the whole detail of the system, illustrating it by plans of the Chambers of Representatives of the Hague (Holland), the Hospital Necker of Paris, the Asile Impériale du Vesinet, and several other buildings warmed and ventilated upon the Van Hecke principle; bringing forward, at the same time, abstracts of reports from the French, Dutch, and Bavarian Governments relative to the system in question. The latter is extremely simple. The fresh air is propelled along an air channel by means of a fan, patented by Dr. Van Hecke, into an air chamber containing a warming apparatus, where it is warmed and moistened, and whence it is distributed over the building. An anemometer and dynamometer placed before the fan indicate at any moment the exact amount of air supplied to the building. The amount in hospitals is

2200 cubic feet (minimum) per hour per bed, but it is capable of being doubled. This quantity of air is supplied without any perceptible draught, and the thermometers in the wards indicate a constant temperature of 60° Fahrenheit. In summer the air is cooled as it is warmed in winter. The vitiated air escapes through flues, each having free access to the external air.

The author, in his description of the warming apparatus, shows that it utilizes the heat of the waste smoke. The warm baths and vapour baths are also supplied by the waste steam of the small engine which works the fan.

To economize heat in winter, the vitiated air escapes from that part of the room at which the temperature is always lowest. The heating chambers vary in number according to the requirements of the building. Enclosed in each is the warming apparatus, consisting of a cast-iron cockle, from the summit of which depart a series of sheet-iron smoke-flues, which, circulating four times round the cockle, in shape of a square, conduct the smoke to a chimney in the wall. To this is added a vessel for moistening the air.—*Builder.*

VENTILATING CHIMNEY-TOPS.

We learn that Hagan's Ventilating Chimney-Tops, which cause an upward current, which are silent in their operation, and which effectually prevent down draughts, are in great demand; having been applied at St. James's Palace; at almost all the Government offices, including the Foreign Office, the War Office, the Home Office, the Post Office, the Mint, the Tower of London, Chelsea Hospital, Regent's Park Barracks; also, at such places as the mansions of the Dukes of Devonshire, Northumberland, and Newcastle. They are also applied to barracks, banks, factories, lodges, &c. They are fixed by placing a course of bricks in cement or mortar on the flange, or they may be made to fit on old chimney-pots if required.—*Mechanics' Magazine.*

LARGE COOKING APPARATUS, REGENT-STREET.

At Mr. Kuhn's, in Hanover-street, a Cooking Apparatus has been put up in the centre of the kitchen. It is 10 feet long, 4 feet wide, and 3 feet high. The fire is placed at one end, and beyond it are fitted two large and powerful roasters and two large ovens, the united cubical contents of which are about 56 feet. Over the fire-roasters and oven is placed a hot-plate of 40 feet area; and at a distance of 2 feet above the hot-plate is a strong rack for holding and heating dishes and plates. Above the hot-plate is a hood, the full length and width of the apparatus, for the purpose of collecting the heat and steam from the hot-plate and cooking utensils. These are conducted away through a pipe to a distant shaft. The cooks are protected from the hot-plate by a bold copper rail. Two boilers form the back and sides of the fire,—one of them having a large hot-water cistern; the other supplying steam to a steam-chest. Within half

an hour of lighting the fire, the apparatus, it is stated, is in perfect working order; and cutlets, &c., are cooked to perfection in the roasters in eight minutes. Mr. Kuhn says he could cook dinners by means of this apparatus for 3000 persons in one day.—*Builder.*

IMPROVEMENTS IN FIRE-ENGINES.

MR. T. TOMLINSON has patented certain improvements in Fire-engines, which are described as follows:—

Here there are three pumps, each double-acting; and they are held in one casting. The piston rods pass through hydraulic packings, and are worked by a crank shaft, the cranks of which are set to operate at different times of their strokes, better to distribute the power applied. This crank shaft is supported across the underside of the engine, with one end projecting on each side thereof, where it is provided with crank arms, each of which is connected to a horizontal rod having a series of arms, forming handles for the operators to hold by. These horizontal rods are controlled to move horizontally, one on each side of the engine, whilst the action upon them is rotary, by their being connected also to other crank arms. The arm, or the crank axis to the horizontal rod, on one side, is set at an angle to that on the other, better to distribute the power applied and exerted. The adaptations are also applicable for working by the aid of steam power. The inlet valves to the pumps open from reservoirs, one to each pump, and each pump is capable of being supplied by a separate supply-pipe, whilst six outlet valves open into a reservoir or valve chamber communicating with the air vessel, and with four or other number of discharge passages, either or all of which may be used for jets.—*Mechanics' Magazine.*

ROBERTS'S PATENT PORTABLE FIRE-ENGINE.

THE advantages of this new Engine are:—

1st. Great power combined with portability.

2nd. Simplicity of construction, and consequent non-liability to derangement.

3rd. Ready access to the interior (the whole of the working parts can be got at in two minutes).

4th. An engine with 12 feet of suction and 120 feet of delivery hose, and all the gear complete, can readily be transported over ordinary roads by one man.

5th. Will throw 60 gallons of water per minute a distance of 80 feet with eight men working, and 103 feet with ten men.

6th. The carriage can be disconnected from the pump in eight seconds, and connected again in twelve seconds.

An engine of the above size has been taken from the engine-house through the factory to the water, a distance of 110 yards, 90 feet of delivery hose run out, and the pump got fairly to work in three and a-half minutes. When the pump is disconnected from the carriage, it becomes a portable pump for ships' use, and can be used with a suction plate, to which it can be connected in a few seconds, and thus obviate the necessity of having standard pumps upon the decks of gunboats or small vessels, where a clear deck is a desideratum. It is equally applicable for any purpose where a lift or force pump is required.—*Mechanics' Magazine.*

EXTRACTION OF FIRE-DAMP FROM COAL-MINES.

MR. J. G. WILLIAMS, of Blaenafon, believes that he has discovered a method by which the carburetted hydrogen gas (commonly known as Fire-damp), which accumulates in such quantities in Coal-mines, can with safety be extracted. His invention, says the *Hereford Times*, is very simple. A receiver, containing a syphon-pipe, is to be placed at the top of the pit, and connected to gas-pipes of a sufficient size (about 2 or 3 inches in diameter), which are to be carried down the pit and through the workings, branch pipes being attached to the main pipes, with stop-cocks at all necessary points. These branch pipes are to be inserted in the roof, or any other parts of the workings where gas is found to accumulate. The receiver at the top of the pit is to be filled with gas, and a burner attached to the receiver will be lit: by these means all the gas which may be in the pipes will be sucked up through the receiver, the burner of which will keep lit as long as any gas remains in the pipes.

EXTINCTION OF FIRES.

MR. J. F. BATEMAN has made a communication to the British Association, "On Street Pipe Arrangements for Extinguishing Fires." Mr. Bateman commenced by stating that in most large towns, as Manchester and Glasgow, for instance, where the supply of water had been taken into the hands of the Corporation, the best preparations had been made for the extinction of fires. But in London, the fire-engines and the brigade were maintained by contributions from the different insurance companies, and it was therefore evident that their interest only lay in preventing the destruction of property that was insured. It was clear that this was a state of things which ought not to exist in this country. Some twelve or fifteen years ago he turned his attention to the subject of the extinction of fires. The old wooden plug or fire-cock was then generally in use, and it still continued in use in some parts of the country. Mr. Bateman described the construction of the branch stand-pipe, with which he had replaced the old plugs in Manchester and other towns, and stated that as a general rule these stand-pipes had been found sufficient without the use of fire-engines. He also explained the principle upon which the water-pipes were laid down in Manchester; so that within reach of nearly every block of valuable buildings in Manchester and the neighbourhood, there were from two to three sources of water supply, and ten or twelve fire-cocks within a hundred yards. Then came the question of pressure. It was popularly supposed that water could be thrown to any height; but this was not so. About eighty or ninety feet was the greatest height water could be thrown by a fire-engine. The highest mills in Manchester were from forty feet to sixty feet, and experiments had been made to show that at the low pressure the stand-pipes would throw ninety feet.

Mr. C. W. *Siemens* explained a system of telegraphic communi-

cation adopted in Berlin in the case of fires, by means of which immediately after a fire occurred the police at every station in the town could be informed of the occurrence, and of the district in which the fire had occurred. He said it was found by the adoption of this system that the fire-engine was generally on the ground five minutes after the alarm had been given.

It is instructive to know that the late Mr. Braidwood to the last protested against the use of cast-iron in the construction of our great river-side warehouses; and pointed out that some great calamity must inevitably befall the men of the Fire Brigade, sooner or later, in their attempts to extinguish the vast conflagrations which were likely to take place in these extensive buildings. His own destruction has been the first testimony to the correctness of his views. The fire raging in one of these warehouses can only be compared to that of a blast furnace; and, in consequence, the cast-iron pillars speedily become red-hot; the water from the hose falling upon these pillars suddenly contracts and snaps them like so much glass; and, of course, the floors fall in at once. Moreover, there is another danger to those outside these warehouses. The massive girders of cast-iron supporting the flooring of course expand with the heat; and no walls, however strongly built, an possibly withstand their lateral thrust; and down they come, to the destruction of those near at hand.—*London Review.*

FIREPROOF DRESS.

THE Emperor and Empress of the French, and suite, have witnessed, in the park of Compiègne, a trial by a M. Buvert, of a newly-invented Fireproof Dress. A cottage was erected in the park for the purpose of the experiment. The framework of the building was iron, and the roof and walls were made of faggots and other combustible materials. The fire brigade attached to the château of Compiègne were in readiness, in case of their services being required. M. Buvert's dress is described to be both waterproof and fireproof, and is copiously stuffed with sponges sewn together. He wears a helmet like that of a diver, with an apparatus for supplying fresh air, and glasses to see through. At a signal from the Emperor, he set fire to the temporary cottage, and when the flames had well got ahead, he went into the midst of them several times with perfect impunity. The Empress, greatly excited by the scene, cried out repeatedly, "Enough; oh, it's quite enough!" The experiment was considered to be entirely successful, and the Emperor warmly complimented M. Buvert upon his invention.—*Times.*

IMPROVEMENT IN STREET LIGHTING.

IT has been ascertained that by placing near the flame of ordinary gas burners a receptacle containing coal naphtha, the brilliancy of the light is much increased. An invention, based upon this principle, is already the subject of a patent vested in a public company. The patentees state that by the use of their process a saving of one-half

may be made in the expense of lighting by gas. To test the accuracy of this assertion, experiments have just been made in London, under the authority of the Commission of Sewers. Moorgate-street was selected for the trial, there being in it few shops, and only one or two private lamps. The lamps experimented upon were twelve in number, six upon the western side, fitted in the ordinary way with burners, and consuming upon the average five cubic feet of gas an hour, and six upon the eastern side, fitted with burners having attached to them the apparatus of the patentees, and consuming two and a half cubic feet an hour. The experiment extended over thirty nights. The burners without the apparatus consumed about 4·39 cubic feet per hour; while the burners with the apparatus consumed only 2·09 cubic feet per hour. The district inspector of the commission, who saw the lamps nightly, reported his opinion that the light given was perfectly equal, an opinion in which he is supported by residents of the neighbourhood. Mr. Heywood, the engineer of the commission, who principally conducted the experiments is, however, inclined to think that the lights are not quite equal in intensity. He states that three cubic feet of gas, carburetted by means of the naphtha, are equal to five cubic feet not carburetted. On this assumption he shows that by the adoption of the new process the reduction of the cost of each lamp a year would be 20s., and that there being 2825 lamps in the City, an annual saving of 2825*l.* might be effected.—*Times.*

AN APPARATUS FOR LIGHTING GAS BY ELECTRICITY

HAS been exhibited at the Franklin Institute, Philadelphia. The machine consists of a small glass disc, revolving between two pads of leather, and giving the generated electricity to points in communication with a brass rod about twelve inches long, terminating in a ball. An insulated handle is attached to the lower part of the instrument. A piece of wire, attached to a sheath which slips over the burner, is so adjusted that a spark given to it from the ball of the gas-lighter passes through the jet of flowing gas and instantly inflames it. The apparatus was manufactured by Messrs. Mitchell, Vance, and Co., of New York.

GAS-ENGINES FOR STEAM-BOATS.

M. LENOIR has propelled up and down the Seine, at Paris, a small iron screw-boat, by means of his Engine, in which the motive power is compressed gas. His little vessel is entirely without oars, sails, chimney, fire, or any other sign of a motive power. This experiment is said to be only a prelude to one upon a larger scale, which will shortly be made by an American inventor, named M. Chandor, who proposes to navigate a pleasure yacht, fifteen mètres in length and two and a half mètres broad, by means of his gas-engine, from the Louvre down the Seine through the North and Baltic Seas, *and to land at* St. Petersburg.

GAS IN THE BRITISH MUSEUM.

NOWHERE has the public money been more wisely expended for good than in the British Museum; yet, somehow or other, this admirable Institution is everlastingly attacked by reformers and innovators of every grade. One set of agitators is for opening the Museum on Sunday; another is for dismembering the whole establishment, and scattering the *membra disjecta* over half London; and still another set clamour for the saloons, &c., being lighted by gas. The late Mr. Braidwood, the superintendent of the London Fire Engines Establishment, in giving his opinion as to lighting up the British Museum in the evenings, said that, independently of the danger of explosion, to which every place where gas is used is liable, notwithstanding the accuracy of the fittings, the use of gas desiccates everything within its reach, especially ceilings, rendering them much more inflammable, and making what would otherwise be a trifling fire a serious conflagration. Mr. Smirke, the architect to the British Museum, reported that he doubted the expediency of introducing gas into the British Museum. The Trustees, after considering these opinions, resolved unanimously that they would not be justified in allowing the collections of the British Museum to be open at any hour which would require gaslight.

It has often been asked why not employ gas more generally in lighting private houses. The above objection of Mr. Braidwood is applicable in this case. All gilding, which is now extensively used in well-appointed houses, is materially injured by gas; all kinds of house decoration—paper-hangings, curtains, and carpets—are blackened by gas; books and prints are much deteriorated by it; and there is a great waste of light on account of its supposed cheapness, economy being in this as in most other cases, a lure to extravagance.

NEW MODE OF LIGHTING THEATRES.

A NEW system of Lighting has been successfully tried at the *Théâtre Imperial de l'Opera*, Paris. The gas-burners are placed below the floor of the theatre, and the products of combustion are carried off by means of glass chimneys and ventilating tubes extending to the roof. The luminous rays are collected by means of a double reflector (the transverse section of which is a sort of shell) and transmitted towards the stage by an opening suitably inclined for that purpose. An unpolished glass placed before this opening destroys the injurious effect attending a direct view of the light or polished metal. This invention will prevent accidents from actresses' dresses coming in contact with the flame; it will destroy a source of heat and emanation injurious to spectators and artists; and by confining below the stage those movements of the atmosphere which are caused by the ascent of the air heated by the burners, it will greatly favour the transmission of sound from the stage to the audience. The light produced by this new method is very brilliant, and uniformly diffused, and the apparatus not being so high as the former arrangement, the actors are better seen. This new system of light-

ing, the invention of M. Lissajous, professor of chemistry, &c., at the Saint-Louis Lyceum, is highly recommended. It provides for the safety of the artists and their health, and improves the music.—*Mechanics' Magazine.*

LUCIFER MATCHES.

M. PASCHER, of Nüremberg, has suggested that sulphide of phosphorus is a good substitute for phosphorus in the manufacture of Lucifer Matches. He states:—It is made of four parts of phosphorus and one of sulphur, powdered coarsely in a porcelain vessel, covering them with water at a temperature of 100° Fahrenheit. The liquid sulphide is formed in a few minutes. The water is then poured off, and a cold thick solution of gum added. The sulphuret quickly mixes with the solution. The sulphide is fluid even at 32°, and inflames easier by friction than phosphorus. 3½ per cent. of the sulphide, with powdered gum and the other ingredients, such as peroxide of lead, sulphide of antimony, and nitrate of lead, is said to produce excellent matches, with less effluvia than the ordinary ones made exclusively with phosphorus.

The manufacture of these trifling articles is now carried on in England to an enormous extent. At one large saw-mill in London may frequently be seen six or eight piles of yellow pine, each as large as a six-roomed house, and all intended to be cut up into lucifer splints. The deals are cut by circular saws revolving with great velocity into pieces three or four inches long, and these pieces or blocks are cut into lucifer splints by a machine in which there are about fifty sharp knives or cutters fixed in a row. Five blocks are cut at once, and the action is so inconceivably rapid, that there are 120 movements of the cutters in a minute, and 250 splints severed and shaped at each cut, so that there are 30,000 cut in a minute, or 1,800,000 in an hour. Three of these machines, working ten hours a day each, would therefore produce 54,000,000 per day.

THE LIME LIGHT.

MR. T. W. TOBIN is said to have assisted the advancement of the Lime Light by the discovery of a new, but remarkably simple principle. He says, "that all symptoms of combustion in gases may be effectually arrested in their course by an intercepting diaphragm of porous carbon, and that the ordinary gas tubing may be made perfectly secure for the production of the oxy-hydrogen flame, by filling it for about 3 or 4 inches with loose pieces of charcoal or coke, and letting the gas filter through it. The advantages of this would be, 1st, the dispensing with a set of gasometer and pipes; 2nd, a very much simpler jet than at present in use, and with all perfect safety that can be depended upon."

WATER AS FUEL.

THE use of Water as a Fuel is now attracting a good deal of attention. *We read in the Revue Universelle*:—"The vapour of water

has already been utilized in metallurgy as an agent of oxidation in the roasting of certain minerals, particularly to facilitate the separation of the compounds of antimony and arsenic in metallic sulphurets. For several years attempts have been made to employ the calorific power of the hydrogen contained in water, and it is the same line of invention that Messrs. Maire and Valler have sought to utilize as a combustible in industrial furnaces, and particularly in metallurgic operations. Water, fed in a regulated and intermittent manner into a hot fire, is decomposed into oxygen and hydrogen. The combustion of the latter in presence of the atmospheric air (the oxygen of the water being employed in burning the carbon) produces a considerable heat in addition to that of the principal combustible. There results, then, a considerable augmentation of caloric without any addition of combustible, and consequently a more rapid fusion of metals and minerals, and an economy of fuel which the authors of the process state varies from 40 to 50 per cent. Experiments and calculations have demonstrated that the heat absorbed by the decomposition of water is less than that furnished by the combustion of the gaseous products of the water decomposed.

COMPRESSED FUEL FOR STEAMERS.

MR. JAMES BRUCE suggests the following modes of making Fuel for Steamers:—1. Boil tar, and stir in as much finely-powdered charcoal as will bring it to the consistence of mortar; then add its own weight of coal-dust; press it into blocks, &c. 2. Steep *sawdust* in a strong solution of nitre; *dry* the same, and then mix it with tar,. and form it into blocks, &c. (Both of these processes were communicated to the Admiralty some months since.)—*Mechanics' Magazine.*

COTTON GINS.

MR. D. CHADWICK has read to the British Association a paper, "On Recent Improvements in Cotton Gins." A description was given of the old Indian churka, one of which was exhibited to the meeting, and the invention of the American saw gin, by Eli Whitney, was also noticed and described. On the recent visit of Dr. Forbes, the superintendent of the cotton gin factory of the late East India Company, to Darwhar, he introduced an improved cotton gin, based upon the principle of the Indian churka. This churka gin had subsequently been improved by Mr. John Dunlop, of Manchester, and Messrs. Platt, Brothers, of Oldham, and the improved machines were exhibited to the meeting. The improvements in Messrs. Platt's machines consisted in the application of spike rollers revolving at different speeds in connexion with vibrating machinery, which transmits the cotton to the ordinary churka rollers. The effect of this is to enable the machine to be supplied with cotton at intervals instead of continuously with the fingers. The machine is intended to be worked by power, and requires the attendance only of a child thirteen years of age. Mr. Dunlop's machine was less expensive,

more compact, bearing a closer resemblance to the original churka, and was intended to be worked by hand.

NEW METHOD OF BLEACHING.

M. Barreswil states (in the *Répertoire de Chimie*) that he has adopted the following Method of Bleaching:—The moistened skin is plunged into a solution of permanganate of potash, and rubbed with a glass roller, in order that the reagent may penetrate the skin, which in consequence becomes brown. It is then well washed and subjected to the action of diluted sulphuric acid, which destroys the oxide of manganese, the cause of the brown colour, and makes the skin a pure white. One more washing finishes the operation. As the author states, the value of the process can only be tested by the manufacturer.

LACE MANUFACTURE.

The growth and importance of this branch of industry may be learnt from the statements made by Mr. W. Felkin in 1856. He calculated that the returns from the Lace Manufacture exceeded 4,000,000*l*. a-year, the number of hands was 135,000, and of machines employed 3500. The machines are now estimated at 4000. By the original mode of making lace upon the pillow, five meshes of "plain net" could be made per minute; 40,000 meshes per minute can be made by machine with ease. In 1813 the price of the finished pieces was 40*s*. the square yard; in 1856, 6*d*.

WOOL AND FLAX FABRICS.

In America a process has been invented for disintegrating Wool by charging it in a cannon with steam, and then suddenly discharging it with explosion. It has been found that flax and hemp, reduced to fine short fibre by the same means, is well adapted for mixing with wool in various cloths. Short flax fibre is capable of being most intimately mixed with the wool in the fulling operation. The shortness of its fibre may unfit it for spinning on cotton machinery, and for weaving into plain cloth, but not for mixing with wool. As there will be a deficient cotton supply this year, there is a necessity of seeking a new material for the production of other fabrics to take the place of clothing composed wholly or mostly of cotton. By increasing the number of sheep, the clip of wool may be vastly augmented; and by using fine flax fibre to mix with wool, we may obtain a great increase in the raw materials for making cloth, and thus in a great degree modify the evils that may arise from a defective cotton supply.—*London Review.*

BOOT AND SHOE-MAKING MACHINERY.

"Blake's Patent Sole-Sewing-Machine" is the invention of a young man from the late United States. It is large and imposing in appearance, and is made upon an entirely distinct principle to that

of any other sewing-machine yet invented, inasmuch as it sews with one thread only, and of course the action is obtained in an entirely different manner. With each revolution of the wheel a formidable needle, holding a good thick waxed thread, descends with a sharp thud into the substance to be sewed, and loops itself underneath and comes up again with a snatch that tightens the stitch much more effectually. The material being sewn at the time of our visit was two pieces of sole-leather just cut from a dry hide; the two measured three-eighths of an inch in thickness, and from the ease with which the needle went backwards and forwards through this substance, there was not the slightest doubt but that it might be made to go through double the thickness if required. The seam is along a channel that is afterwards closed up so effectually that it is difficult to see the stitches, and the old channel-sewn sole is again produced as perfect, and even much more perfect than it used to be by hand.

In the making of boots and shoes by this machine the sole is arranged for the "upper" to come between the inner sole and the outer one; the boot is then placed under the machine, and without the necessity of a welt, the whole is fastened together by stitches that go through the entire thickness of soles and upper, yet so neatly as to leave no ridge to irritate a tender foot on the inside, or expose the sewing to the wear of the pavement on the outside. When it is added that a pair of soles can be sewn on and completed in three minutes, it will be seen how completely impossible it is for human labour to compete with this machine. When the machine was first invented only the sides were sewn up, and the toes and heels were left to be pegged or nailed; now, however, by a very beautiful contrivance, the machine can be made to sew round the toe and heel of the boot with the same ease as any other part. It is calculated that a woman could superintend one of these machines, and turn out 100 pair of boots per day on an average.—*Abridged from the Builder.*

The *London American* states,—a manufactory has been established in Haverhill, U.S., in which nearly every part of the shoe is made by machinery. Twenty-five persons produce, by this means, 600 pairs of shoes daily. All the stitching is done by sewing-machines run by steam. The shoes manufactured in this factory are "pegged," and every operation except fitting the shoe to the last, even to the final polishing and cutting the pegs out of the inside, to prevent them from hurting the foot, is performed by machinery. One of the greatest curiosities is the pegging-machine, which inserts the awl, cuts out the pegs from a strip of wood, and drives them in, all at one operation, and so rapidly that it will peg two rows around the sole of a shoe in twenty seconds. The facilities in this manufactory are such that the raw calfskin and sole leather can be taken in at the basement of the building, and in half an hour turned out in the form of a complete pair of shoes.—(For Southall and Stennett's Boot and Shoe-Making Machinery, see *Year-Book of Facts*, 1861, p. 120.)

GOOD COMPRESSED BREAD,

To replace the perishable and indigestible hard biscuit used by the French Army and Navy, has been recently prepared by M. Dupuyparlier, of Beauvais. Small loaves baked in tins are throughly dried and then pressed into cakes (four inches square and three-quarters of an inch thick) by a machne invented and patented by M. Marinoni, of Paris. The cakes recover their original dimensions when put into water. They have been tasted and approved of by the Emperor, who has ordered 2000 rations (four cakes each) to be made of this bread.

INDIA-RUBBER VARNISH.

DR. BOLLEY has published the following improved process for making this Varnish:—If India-rubber be cut into small pieces and digested in sulphuret of carbon, a jelly will be formed; this must be treated with benzine, and thus a much greater proportion of caoutchouc will be dissolved than would be done by any other method. The liquid must be strained through a woollen cloth, and the sulphuret of carbon be drawn off by evaporation in a water-bath; after which, the remaining liquid may be diluted at will with benzine, by which means a transparent, but still yellowish liquid will be obtained. A more colourless solution may be prepared by digesting india-rubber cut into small pieces for many days in benzine, and frequently shaking the bottle which contains it. The jelly thus formed will partly dissolve, yielding a liquid which is thicker than benzine, and may be obtained very clear by filtration and rest. The residue may be separated by straining, and will furnish an excellent waterproof composition. As for the liquid itself, it incorporates easily with all fixed or volatile oils. It dries very fast, and does not shine, unless mixed with resinous varnishes. It is extremely flexible, may be spread in very thin layers, and remains unaltered under the influence of air and light. It may be employed to varnish geographical maps or prints, because it does not affect the whiteness of the paper, does not reflect light disagreeably as resinous varnishes do, and is not subject to crack or come off in scales. It may be used to fix black chalk or pencil drawings; and unsized paper, when covered with this varnish, may be written on with ink.—*Galignani.*

BROWN STAIN FOR WOOD.

A CORRESPONDENT of the *Builder* suggests as an economical Brown Stain for Woodwork, Condy's fluid (green), which sells at 5s. per gallon. Its action is instantaneous, and its colouring matter fixes itself indelibly in the fibre of the wood, without any preparation or second application. This fluid is permanganate of potash, and is capable of staining light wood of a brown tint, or rather of a series of brown tints, from very light to very dark, according to the quantity absorbed. Permanganate of potash is a very curious substance in many respects. Even in its mere physical aspect it

has the singular property of changing to a variety of hues—from green to purple, and from purple to brown ; and hence it has long been known as "the mineral chameleon." Schönbein, the discoverer of ozone, found it to be a direct and perfect ozonizer, or vehicle communicating ozone, as a cleansing and scavenging principle ; and it is now used in Government and other hospitals, as a cleanser and deodorizer of wounds, and as a general sanitary agent. It is the same substance which Dr. Angus Smith converted into a test for th purity and impurity of the atmosphere, and which Miss Nightingale recommends for use in hospitals and dwellings for the same purpose.

NEW PAINT FROM ANTIMONY.

MESSRS. HALLETT AND STENHOUSE have patented the manufacture of a Paint from native Oxide of Antimony—a mineral which is found in considerable quantities in Spain, Borneo, and other localities, where it is usually associated with the grey sulphide of antimony ; from this it has been produced by the process of oxidation, which, as might be expected, is found to be more or less complete. According to the *Journal of the Society of Arts*, "The oxide is first reduced to coarse powder, and is then roasted for three or four hours, at a low red heat, with free access of air, in muffles or other suitable furnaces. During the process of roasting, the sulphur and other volatile matters are expelled, the colour of the substance becomes much paler, and the residuary metal is converted, for the most part, into antimonious acid. The calcined product is then reduced to an impalpable powder by being ground in flint mills ; and, when dried and mixed with oil constitutes the paint. The paint has a delicate stone colour, and is quite equal in body or capacity to the best white lead ; while it possesses the great advantage of maintaining its colour in vitiated atmospheres—being not acted upon either by acids or sulphuretted hydrogen. This property renders it peculiarly adapted to interiors of ships, gas-works, and hospitals. It is devoid of anything hurtful to workmen, either in its manufacture or use ; and as (weight for weight) it will go fully 25 per cent. further, as a pigment, than the best white lead, and its price being considerably lower, the new antimony paint promises, ere long, to be very generally employed."

NEW GREEN DYE.

THE Chamber of Commerce of Lyons has awarded a prize of 600 francs to M. Charvin for his discovery of a colouring matter extracted from an indigenous plant, the rhamnus catharticus (buckthorn). It is equal in quality to the valuable China green, and can be produced at very small cost. Silk dyed with this matter is said to retain its beauty by artificial light.

THE MAUVE COLOURS.

THE great interest that attaches to these Colours does not consist in their novelty only, but in the fact of their being produced from *coal*, and in their importance, technically speaking, as permanent and beautiful dyes. The production of the Mauve dye reposes upon that of a very remarkable substance called aniline, which is found in gas-tar, but only in minute quantities. A host of curious compounds have been found in gas-tar, and among them aniline, which, in a pure state, appears as an oily transparent liquid, possessing properties such as characterize those substances called "alkaloids," as quinine, strychnine, nicotine, &c. It would probably form a medicine similar in its effects to sulphate of quinine, but at present science has only employed it to yield dyes of a beauty never witnessed before its discovery. The great merit of the mauve dye is the beauty and permanency of the tints which it imparts. Its power of colouration is so great, that a small quantity of it gives colour to a large number of vats. While coal would hardly sell at one farthing per pound, a similar weight of aniline dye is said to be worth from 60*l.* to 80*l.* sterling.—*Dilettante Review.*

LIQUID GLUE.

THE following recipe is given by the *New York Tribune* for making the liquid glue now so popular in America:—In a wide-mouthed bottle put eight ounces of best glue in a half-pint of water, set it in a vessel of water, and heat it till dissolved. Then add slowly, constantly stirring, two and a half ounces of strong aquafortis (nitric acid). Keep it well corked, and it will be ready for use. It is a handy and valuable composition, as it does not gelatinize, nor undergo putrefaction and fermentation and become offensive.

EXTRACTION OF BUTTER.

WE give the results of M. Barrall's experiments on this important subject, reported in *Cosmos*. The time required for the formation of Butter varies considerably with the temperature. At 53° Fahr., about ten times more time is required than at 68°; at 86° the time needed is about one-half less than at 68°. Another remarkable fact is, that when the temperature of the churning is too elevated, the yield of butter diminishes considerably. The most suitable temperature when milk is operated on is between 64° and 68°. The loss is much less when cream is churned instead of milk. The most suitable temperature for obtaining from cream the greatest amount of butter in the shortest possible time is between 57° and 60°. With the same apparatus, by varying the temperature, the duration of the operation may be varied in the proportion of ten to one, while very variable amounts of butter are produced. M. Barrall's experiments have been verified by the great agricultural chemist Boussingault.

CASELLI'S PANTELEGRAPH.

At the Italian Exhibition held in Florence, in the whole of the vast department of machinery, Caselli's Pantelegraph proved one of the most attractive objects. The successful inventor has established a communication between Florence and Leghorn, and himself attends at the Crystal Palace to exhibit the results of his admirable contrivance. He was a disciple of Nobili and Amici, those distinguished natural philosophers who have done so much for the increase and diffusion of electro-magnetic science. His pantelegraph is intended for the transmission of messages immediately from the hand of the writer, conveying a facsimile of every word and syllable, and bearing the full authenticity of the hand and signature. A banker at Paris or London may thus hereafter draw a cheque upon Turin or Florence, which his Correspondent will honour at sight, being as sure of the identity of the document as if he had the very paper on which it is written. In one word, it is the reproduction, at a distance, of anything that pen or pencil can produce. A small point, somewhat like the hand of a watch, runs semicircularly, moved by a very simple machine, upon a chemically-prepared paper, tracing almost invisible lines, the aggregate of which soon embodies the words line by line, or the various parts of the design, till the whole stands before us. The action is so rapid, that the average transmission is of 12 words in a minute, being somewhat quicker than the usual mode of telegraphic communication, with the avoidance of all possible mistake or uncertainty.

A NEW WIND AND WATER MILL.

M. Bernard, of Lyons, has presented to the Paris Academy of Sciences, an apparatus by which he proposes to utilize, in a complete and permanent manner, the force of the Wind, and, by its means, that of Water also. The predominant idea in the apparatus, which M. Bernard developed in a model, was much admired, as very new and ingenious. It consists in the enabling the greater or less force of the wind itself to rule the elevating force of the pump which it puts in motion, in such a manner, that the effect produced should be always proportioned to the intensity of the cause, or that the cause should always produce the effect of which it is capable. Let us suppose that, instead of the wind, the cause of the motion of the pump is alternately the arm of a man, a youth, and a child. The two latter would work the pump as readily as a man, by the fact that, as a weaker arm succeeds a stronger, the effect of the pump would be regulated according to the strength of the arm giving the impulsion. Details will be found in *Cosmos*.

NEW MACHINERY FOR WORKING WOOD.

Messrs. Thomas Greenwood, of Leeds; and Arthur Kinder, of Great George-street, Westminster, have patented certain improvements in Machinery for Cutting or Working in Wood, relating, first,

to machinery for cutting rebates in timber that has or has not been previously squared; secondly, for cutting mortises in timber; thirdly, for constructing and arranging the bearings of band saws; and, lastly, for surfacing or smoothing the face of timber. The next improvement in mortising machines consists of an arrangement of mechanism for bringing down the cranked axis which works the cutters, so that at each succeeding stroke the cutter will penetrate to a greater depth until the chisel or cutter having arrived at the stop, its motion will be arrested, and the mortise will be finished to an even depth throughout. The next improvement relates to the standards for supporting the bearings of the upper pulley of a band or ribbon saw. The next improvement relates to machinery for smoothing or planing the surface of timber or wood. These inventions cannot well be described or understood without engravings, but an account of them will be found in the *Engineer* journal.

THE NEW FLAGSTAFF AT KEW.

A VERY fine spar has been set up in the Royal Gardens at Kew, the gift of Mr. Stamp, at Rotherhithe, which, though a single stick, is nearly twice as high as the surrounding trees. It is a specimen of the Douglas Pine, a native of British Columbia. This noble spar measured, before cleaning and rounding, 159 feet in length, the diameter of the butt end being 22 inches, and that of the top end 8 inches. It contained about 150 annual layers. Such a spar for size or beauty has never been seen at any of Her Majesty's dockyards. On the extreme summit, a star has been placed, with looking-glass facets and points surmounting the vane-staff and reflecting the sunbeams. The rigging was fixed to strong supports deeply buried in the earth, and there loaded with heavy blocks of stone. The dimensions of the spar are as follow :—

	ft.	in.
Total length of the spar	159	0
Under ground, in the bricked well	11	6
From surface of ground to crosstrees	67	0
From crosstrees to topmast rigging	67	0
From topmast rigging to truck	13	6
Length of iron crosstrees	15	6
Diameter of truck	0	10
Diameter of staff at heel	1	7
Diameter of staff at top	0	7
Cubical contents of staff	160	0

Total weight complete, 4 tons 8 cwt. 2 qrs. A cubic foot of the timber weighs 58 lbs. 12 oz. The age of the tree was probably not much less than 200 years, and its total height 220 feet.—*Builder.*

PAPER FROM WOOD.

IT is said that a French lady has succeeded in manufacturing excellent Paper from Wood, and at a price much lower than that made from rags. Her method consists chiefly in the use of a new kind of machinery for reducing the wood to fine fibres, which are afterwards

treated with the alkalis and acids necessary to reduce them to pulp, and the composition is finally bleached by the action of chlorine. By means of a series of parallel vertical wheels, armed with fine points, which are caused to pass over the surface of the wood in the direction of its fibres, the surface of the wood is marked, and the outer layer is formed into a kind of net without woof, composed of separate threads. This layer of fine threads is afterwards removed by means of a plane, which is passed across the wood, and the portion thus removed, which resembles lint or flax, is then treated with chlorine, &c. Specimens have thus been made consisting of a mixture of 80 per cent. of wood-pulp, and 20 per cent. of rag-pulp, and sheets have been tried by printers, lithographers, and others, with very satisfactory results. It is the unanimous opinion of the engravers and lithographers who have used it, that paper made according to this method from wood, and which costs only 400 francs (16*l.*) per ton, is quite equal to the China paper, which costs 5350 francs (214*l.*) per ton. It is confidently expected that experiments upon a larger scale will confirm the results already obtained.—*Mechanics' Magazine.*

PERFUME VAPORIZER.

A SIMPLE apparatus, capable of being made very useful as a sanitary agent, as well as for the diffusion of merely pleasant odours through apartments, hospitals, halls, theatres, &c., has been invented by Mr. E. Rimmel, the well-known perfumer. It consists of a vessel heated by a small lamp below it, and intended for the vaporization of steam impregnated with the odours of flowers, aromatic vinegar, or other acids, and sanitary agencies, such as chlorine, ammonia, &c. Even some perfumes are believed to act not merely as ministrants to luxury or pleasure, but as sanitary agents; by, it is believed, ozonizing the oxygen of the atmosphere, and so converting it into true *vital* air; and one essential oil we particularly know of, namely, oil of cloves, which though heavy as a mere perfume, has a very singular power of destroying musty mould, as in paste or gum, for example; and keeping it sweet and fresh for months; while, otherwise, in a few days it would be utterly useless. Such an agency, diffused by Rimmel's Vaporizer, in close and musty apartments, could not but sweeten them; but the choice of perfumes and such like is endless. Dr. Hassall, who with Dr. Letheby and others, recommends this apparatus as a useful sanitary agency, states that, if even the delicate flower-leaves of the violet or rose be thrown into the vaporizer, their scent will be diffused throughout a room without any of that acrid and offensive empyreumatic odour which is so apt to accompany the *combustion* of perfumes, as on the burning of incense or pastiles.—*Builder.*

PREVENTION OF WRITING FROM BEING EFFACED.

M. NECHT SENNEFELDER has published a curious process for rendering writing ineffaceable for purposes of fraud. It consists, says *Galignani*, in dipping the paper on which a bill or cheque is to

be written for a few seconds into a solution of gallic acid. When the paper is dry, it is fit to be used for writing on with common ink. Suppose any person were, with criminal intent, to endeavour to efface a word from the documents, he would either have recourse to the chloride of potash or the oxalate of potash for the purpose, and would find, to his dismay, that these substances produce a black ring or border round the characters, which it is impossible to efface without destroying the paper.

STABLE SMELLS.

A CORRESPONDENT of the *Times* suggests the following simple means of counteracting the unpleasant Ammoniacal Smell in Stables. "If those who have stable manure will take four ounces of sulphuric acid and two gallons of water, and mix them in a garden watering-can, with the rose on, then sprinkle the contents over the manure every evening (supposing it to be a cartload), it will counteract the unpleasant smell. Its action is this :—The ammonia as it arises from the manure is fixed by the acid. As the acid in its concentrated state is very powerful, it requires much care; also when in its diluted state care must be taken that none of it is spilt on the user's clothes. It is also requisite to rinse the can out immediately with water. I would also observe that as many stables are very offensive and most unwholesome from the ammonia, which is continually arising, if in such stable a leaden trough, something like what ladies grow mignonette in, in their chamber windows, were fixed over the stable doors in an aperture, leaving a small space open above the box into the stable-yard, and this box were two-thirds full of a mixture of two pounds of strong sulphuric acid—and three quarts of water, the stable would be comparatively sweet. Ammonia has a great affinity for sulphuric acid, thus forming sulphate of ammonia, which is one of the very best manures we have. I would also say that if tallow-chandlers would put four ounces of chloride of lime into two quarts of water, stir it about for a minute, then let it stand half an hour before they put the rough fat into the copper, and put the clear liquid of the above in, it would take all the unpleasant smell away so much complained of at this season of the year, and would do no injury to the tallow."

A NEW CEMENT.

M. KUHLMANN has sent a communication to the Paris Academy of Sciences on a means of deriving profit from the refuse of raw soda, which is a great nuisance in the soda manufacture. He mixes together equal parts of the refuse of the soda and of that of the sulphuric acid manufactories, and thus obtains sulphate of lime, that is, plaster of Paris. The manipulation of the two mixtures is rendered perfect by grinding the mass under a vertical millstone; and when it has become sufficiently homogeneous, it may be moulded into architectural ornaments, which in course of time become as hard as

brick. The compound, it is said, acquires in a moist atmosphere more hardness than in a dry one, and at length becomes extremely sonorous : its colour is like that of common earthenware. It will, after a certain time, resist the effect of frost ; especially when, while fresh, its porosity has been diminished by compression ; or when, somewhat later, it has been watered with a solution of silicate of potash.

STONE PRESERVATIVE PROCESSES.

In the *Year-Book of Facts*, 1861, we devoted several pages (95—103) to the proceedings of the year with respect to the induration of the stonework of the Houses of Parliament ; the latest record of 1860 being—that time could only decide the relative merits of the Ransome and Szerelmey processes.

The discussions on the various processes have been resumed by the Royal Institute of British Architects ; but to report these proceedings, mixed up as they are with discursive illustrations of minor interest or value, would far exceed our limits. We must, however, find room for a few details of these discussions. Mr. Tite, in addition to a very able address on the subject to the Institute, made the experiment of mixing water-glass with a solution of muriate of lime, which produced a hard insoluble substance ; and he observed that if it were possible to devise the means of combining that substance intimately with the surface of the stone, it would be an effectual preservation.

Mr. Smith, the only surviving Commissioner of those appointed for the purpose of selecting the stone, states that after numerous investigations and consultations, with competent authorities, the Commissioners reported that the stone found at Bolsover Moor, and the neighbourhood, would be most suitable for the purpose. It is a mistake to suppose that the foundation of the Houses of Parliament has been built with Bolsover stone ; for, though that quality of stone was preferred, it could not be quarried in blocks sufficiently large for the purpose ; and he alone went down to examine in what part of the neighbourhood the same kind of stone could be procured. He found the same, or a similar, bed of magnesian limestone at Anston, and he brought a slab of it, six inches by nine, to London, where it was submitted to the other Commissioners, who decided that that stone should be used. He represented that it would be necessary that some one should be on the spot to see that the quarrymen got the stone from the bed selected ; and it was arranged that he was to go to Anston once or twice a week to inspect the working, for which he was to have received a salary of 150*l.* per annum. But when he required to know by whom that salary was to be paid, no one would take the responsibility of paying it ; consequently, the arrangement was not carried into effect, and the men were left to quarry the stone as they liked. To that circumstance Mr. Smith attributes the unsound quality of a great portion of the stone that was employed. In building the Museum of Practical Geology with the same kind of stone, the workmen were properly inspected ; for Sir Henry de la

Beche said he was determined that the stone of that edifice should stand. The care bestowed in the quarrying had that effect, for whilst the Houses of Parliament are rapidly crumbling, the Museum in Jermyn-street exhibits not the least appearance of decay.

Mr. Warrington, the operative chemist of Apothecaries' Hall, explained the chemical action of Mr. Ransome's silica process. It consists in applying to the stone in dry weather several washes of a weak solution of silicate of soda, commonly called water-glass, which enters the pores of the stone. A solution of chloride of calcium (muriate of lime) is afterwards applied, and these combine together in the stone and form silicate of lime, the insoluble substance produced in Mr. Tite's experiment. Mr. Warrington said that as the interior of the stone contains a quantity of moisture, an efflorescence would appear on the surface, though the particles of the stone might be indurated; and any process that stopped up the pores of the stone must produce exfoliation of the surface.

Mr. Gilbert Scott remarked on the various processes that had been adopted for the preservation of stone—viz., that of Mr. Daines, which consists of sulphur and boiled oil; that of M. Szerelmey, which he endeavours to keep secret; and that of Mr. Ransome. He spoke hopefully of the two latter processes.

Mr. Godwin mentioned the complete failure of Mr. Daines' process, as applied to the statue in Caen stone of Mr. Coram, in the front of the Foundling Hospital.

The most important step is that which was taken by the First Commissioner of Her Majesty's Works and Public Buildings by the appointment of a Committee to inquire into the Decay of the Stone, and the best means of preserving it from further injury. This Committee has examined witnesses and received communications, and reported thereon to Parliament, adopting, as the main objects of inquiry: 1, the extent and position of the decay; 2, the causes to which it is attributable, taking into consideration the composition of the stone, and the influence exerted upon it by moisture, and by the acids diffused in the London atmosphere; 3, the best means of preserving the stone from further injury; 4, the qualities of the stones to be recommended for future use in public buildings to be erected in London. Much of the Report is of a formal description, so that we shall only give the results in a few words.

1. With regard to the extent and position of the decay, the general result of the observations, confirmed by the evidence, would seem to suggest that the stone used in the Palace of Westminster is much more likely to decay in damp and sheltered situations than where it is exposed to the full action of atmospheric influences. It does not appear that the decay is attributable, as is commonly supposed, to the stones in the building not being placed upon what is technically called their natural bed, or in the same relative position as they occupied in the quarry; thus, stones which are found horizontally in the quarry appear to have been often placed perpendicularly in the building, and used for purposes of the most delicate decoration, without any injurious results. The extent of the decay

is considerable for a building so recently erected, and it is apprehended that there may exist much more mischief than at present is actually apparent. The decay appears mostly on the plain surfaces, whilst the finer and more elaborately wrought portions of the building, unless under projections, are not seriously affected. The decay does not at present affect the stability of the structure.

2. As to the *Causes of the Decay*, the Report of the chemists, who were members of the Committee, must be consulted. The following portion of the Report, condemnatory of the mismanagement and shortsightedness of the Commission, is too important to be omitted :

The Committee venture to remark, that it is much to be regretted that the offer made by one of the Commissioners, particularly well acquainted with the selection and working of stone, to examine that used in the Palace at Westminster for the moderate salary of 150*l*. per annum, was not accepted, owing to some difficulty in regard to the party who was to be held responsible for this unimportant amount; and that the matter was left to persons who admit that they had little or no prior experience of this description of stone, though they evidently entertained suspicions of the durability of some of it which they were employing.

3. As to the *best Means of preserving the Stone from further injury*, the Committee

are decidedly of opinion that it is not necessary nor desirable to proceed with any general coating, painting, oiling, or washing of the whole building. It is quite obvious, in their judgment, that a very large proportion of the stone does not require any such application; but that what is wanted is some efficient process which should be applied to the surface of any stone that begins to show symptoms of decay, with a view to arrest its progress. The Committee believe, that the persons to whom the care of the building is entrusted ought to watch it, and note, in the earliest stages, wherever decay is perceptible, by efflorescence, change of colour, crumbling, or slight decomposition.

In cases where the decay is important, and evidently occasioned by the fall of rain on an upper projecting or exposed surface, protection should be afforded by a covering of sheet zinc or lead; and if, hereafter, any composition should fortunately be discovered, by which the decaying stone could be at once covered or coated, and the injurious influences of the atmosphere prevented from further acting upon it, the difficulty would be solved. In some extreme cases the decayed stone might be cut out, and replaced by a new one. With regard to the processes which have actually been applied, whether experimentally or extensively, the Committee are decidedly of opinion that the discovery of a proper mode of treating stones in a state of decay has not yet been made; and there is no evidence whatever on the building itself to induce them to believe that the decay, where decay has arisen, has been arrested, or that permanently the decay has been prevented by any of the processes yet applied.

The chemists, in their Report, state that with respect to the best means of preservation—

That the nature of the inquiry is so extensive, and that time is so important an element in the solution, that they are unable to give any opinion upon the subject. They further state, that they spent five whole days in the examination of only one suggested remedy; but they are unable, notwithstanding, to give any opinion on even that one suggestion. They allude to secret processes, regarding which they say they can offer no opinion; but they express a doubt of the applicability of any suggestion which would demand the veil of secrecy for protection. Concurring in this view, it may be further noted that even if such applications were found successful in sample or experiment, no security would be afforded for a corresponding success in any subsequent large operations. They recommend that a series of experiments should be conducted, under chemical supervision, for a considerable period of time; and the Committee are most reluc-

tantly compelled to coincide with them, and to urge upon the Government the adoption of such a course.

4. As to the qualities of the stones to be recommended for future use in public buildings to be erected in London,

The Committee have been unable, in the time allotted to them, to go into any very extensive examination. It is obvious, however, that although some varieties of magnesian limestone are an excellent and durable material, when not exposed to the deleterious influences of the London atmosphere; yet that in London it is subject to causes of decay, which render it an undesirable and unsafe material for the construction of public buildings. The Sub-Committee are of the same opinion.

It is equally obvious that Portland stone, well selected, has been used in buildings in London from the date of St. Paul's downwards, under circumstances of great exposure, and with most successful results. Portland stone is a material to be obtained in any quantity, and in blocks of any size, beautiful in colour and texture, reasonable in price, not by any means so hard as the Anston stone, and yet with a power of resisting the influences of the London atmosphere, that leaves but little to be desired. It must be remarked, however, that Portland stone should be carefully selected; an operation which would be the most satisfactorily effected by an agent at the quarries.

The Committee, in conclusion, recommend that the architect of the Palace of Westminster, assisted by scientific chemists, should examine and record the actual state of the stone-work of the building at the present moment; that experiments should be made by their direction, under various conditions of height, exposure, and aspect, with such preservative materials and agents as the chemists may suggest from time to time; and that researches should be continued into the effects of the various alkaline silicates, the phosphates, and other substances which have been brought under the notice of the Committee, or suggested in Germany, France, or elsewhere; that where decay arises from damp, means should be taken to protect the stone, as has been before suggested; that any stone extensively decayed should be removed and replaced; but that in particular the earliest symptoms of decay should be carefully watched, and examined, with the view to the application of some immediate remedy. The Committee believe that a very large portion of the stone in the Palace of Westminster is of a very durable nature; and they entertain a confident expectation that a remedy will soon be found to arrest or control the decay when it has unfortunately begun to appear.

The Report of the Sub-Committee of chemists examines the processes proposed for permanent and temporary protection. Of the processes which are intended to afford permanent protection to the stone, and the use of which is not precluded by the conditions of the case, there are several which claim a careful investigation. These processes may be classed under the following heads:—

1. Application of silicates of the alkalies, in various states of concentration.
2. Application of silicates, in conjunction with various saline compounds, intended to produce double decomposition.
3. Application of hydrofluoric or hydrofluosilicic acid, or their saline compounds.
4. Application of phosphoric acid, and acid phosphates.
5. Application of solutions of the alkaline earths, or their bicarbonates, in water.

All these processes are more or less based upon chemical considerations, which are supported by analogy, and which, in the case of the two first-named classes, have received considerable experimental confirmation. The experiments which are now in progress with several of the processes included in the two first subdivisions will, it is believed, in the course of a few years furnish ample data for correct conclusions regarding their applicability. In the meantime it might be advisable to apply to portions of the New Houses of Parliament actually undergoing decay, certain processes selected as representatives of the remaining classes above enumerated, in order that their merits might be submitted to the only conclusive tests—those of actual application, and protracted exposure to the corrosive influence of a London atmosphere.

As to processes which are only calculated to afford protection of a temporary character, the Committee recommend further trials, upon the consideration that substances, included under the appellation of organic, differ essentially in their powers of resisting the destructive action of the atmosphere. Whoever is acquainted with the nature of organic substances, cannot fail to appreciate the different degrees of stability under atmospheric influence exhibited by gluten, gelatine, or starch (which we find enumerated among the proposed protective agents), and by bees-wax and paraffine, not to speak of many of the fossil gums, which exhibit a degree of permanence approaching that of mineral substances.

The materials recommended for selection to be tried in comparison with linseed oil, are paraffine, bees-wax, and some of the more permanent gums and resins, applied in the form of solutions in volatile solvents.

The following is a list of the experiments and the buildings experimented on:—

Mr. Page, in 1857, operated on the 7th, 8th, and 9th buttress, plinths, and dies, with intervening bays, to the same extent of the river front of the Houses of Parliament (counting from the south end).

Mr. Daines, in 1854, operated on the bay facing Old Palace-yard and adjoining the Victoria-tower and the battlements of the quadrangle of the Commons' inner court; in 1856, on a portion of the parapet on the river front; in 1857, on a portion of the large cornice of the Conservative Club, St. James's-street.

Mr. Ransome, in 1857, operated on the plinths and dies of buttresses on either side of the Commons' entrance on river terrace of the Houses of Parliament; in 1858, on the plinths and dies on either side of Peers' entrance on river terrace of Houses of Parliament; in 1859, on Bloomsbury Chapel; in 1860, on the Marquis of Westminster's residence, Grosvenor-street; and on the Institution of Civil Engineers, Great George-street, Westminster.

Mr. Szerelmey, in 1858, operated on the South side of the Star Chamber-court of the Houses of Parliament; and in 1859 on the Speaker's-court, ditto; in 1860, on Salter's Hall, City; on the statue of Victoria I. at the Royal Exchange; and on part of Spurgeon's Tabernacle, Newington.

As regards the experiments yet made for preventing the further decay of the Houses of Parliament, it appears that the following results have been obtained. We get our information from Mr. Scott's Report on the experiments made on rapidly-decaying stone in Westminster Abbey:—

1. *Water-glass.*—Tried in 1857 and 1858. Stone hardened, but decay only *partially arrested.*

2. *Paul's Aluminate of Potash.*—Tried same date. Same result as No. 1.
3. *Ransome's Silicate of Lime Process.*—Same result.
4. *Szerelmey's Secret Process.*—Stone much hardened. Decay only slightly visible. Mr. Faraday thinks this method to be the best.
5. *Soap and Alum Process.*—Effects appear to have ceased.
6. *Roche's Silicate.*—Effects remain, but efficiency not reported on.
7. *Shellac in Spirits of Wine.*—Admirably successful where protected from rain. Scarcely so successful where exposed to rain.
8. *White Wax in Turpentine.*—Failure.
9. *Same as* No. 8, *but with addition of Stearine.*—Better, but failing.
10. *Daines' Oil and Sulphur Process.*—Tried since July, 1859. Almost entirely successful.

The above results are most encouraging. When, in a matter of such import, 30 per cent. of the methods tried are *almost* complete successes, every hope may be entertained that soon some processes may be discovered *quite* equal to the demands upon them.

Among the miscellaneous lights thrown upon the failure in the selection of the stone is the following statement in the Rev. John Raine's *History of Blyth*, in the counties of Nottingham and York—a quarto volume, just published:—

"It is known to most of my readers that from the quarries of the Duke of Leeds and of Charles Wright, Esq., adjoining the village of North Anston, in the West Riding of the county of York, and touching each other, was obtained the stone with which the new Houses of Parliament were built, and that it is beginning to perish. Mr. Wright gave me recently, on the spot, the following explanation of this fact. In the first place, the contractors took stone from quarries of the Duke, which was visibly unsound and of inferior quality, although soft to work. 2. They won stone too near the *basset-edge*—to use Mr. Wright's own expression—that is, they won it from the surface forwards, driving, so to speak, the quarry before them, instead of working deep from the first. And 3. The quarries of the Duke were, in several instances, marked by fissures, which had become filled with soil; and the consequence was, that the stone in contact with these fissures was soft and bad. Mr. Wright's quarries were deep, perfect, and sound, and the stone thence taken good. This explanation of a practical man, in itself interesting, will, I think, answer the purpose for which I give it, and elucidate the word *berset*, *basset*. It must mean *sloping*, and this interpretation corresponds with the actual character of our Bassetlaw."

ARTISTIC ORNAMENTATION.

Mr. Hancock, the well-known jeweller and worker in the precious metals, having considerably enlarged his establishment in Bruton-street, Bond-street, for the Ornamentation of the principal saloon has commissioned the celebrated talent of Mr. Owen Jones in decorative art. The ceiling is Alhambresque in style, costly in its character, and of the most delicate colours, harmonizing with the show-cases, in which are displayed the almost priceless jewels, in every style of workmanship, from the lighest filigree to the most massive patterns. The colouring of the columns and the wall ornaments is very light, not any being positive, yet strong in tone and classic design, without frigidity; and ornamented with massive castings of the Council Medal of the Great Exhibition of 1851, and the *medaille d'honneur* of the French Exhibition, with which the establishment has been honoured. The show-rooms below, and fire-proof receptacles, are extensive and complete. The house of business, facing Bond-street, is reserved for plate; while the addition, which Mr. Owen Jones has decorated with so *much skill and taste*, is appropriated to jewels.

Natural Philosophy.

THE ROYAL SOCIETY.

THE Fellows of the Royal Society assembled in considerable numbers at their anniversary meeting on St. Andrew's Day—a meeting more than usually interesting, as Sir Benjamin Brodie, the President, then delivered his farewell address on resigning the chair. The attention with which the eminent surgeon's words were listened to marked the feeling of respect and admiration for his character that prevails among the Society over whom he has so well presided.* After the delivery of the Medals, the meeting proceeded to ballot for council and officers for the ensuing year, and the following were declared duly elected:—President, Major-General Edward Sabine, R.A., D.C.L., LL.D.; Treasurer, William Allen Miller, M.D., LL.D.; Secretaries, William Sharpey, M.D., LL.D., Mr. George Gabriel Stokes, M.A., D.C.L.; Foreign Secretary, Mr. William Hallows Miller, M.A.; other members of the Council, Mr. John Couch Adams, M.A., D.C.L., Sir William George Armstrong, C.B., Benjamin Guy Babington, M.D., Sir Benjamin Collins Brodie, D.C.L., Mr. George Bowdler Buckton, William Benjamin Carpenter, M.D., Sir Philip de Malpas G. Egerton, William Fairbairn, LL.D., Captain Douglas Galton, R.E., Mr. William Robert Grove, M.A., Q.C., Mr. William Hopkins, M.A., LL.D., Mr. John Lubbock, Mr. James Paget, Mr. J. Prestwich, Mr. W. Spottiswoode, M.A., Mr. J. Tyndall. The anniversary Dinner of the Fellows and their friends was held at St. James's Hall.

The Copley Medal, in the gift of the Royal Society, has been awarded by the Council to Professor Agassiz, thus setting the seal to the opinion which has so long prevailed of the merits of the distinguished professor. One of the Royal Medals has been awarded to Dr. Carpenter, F.R.S., for his researches on the foraminifera, into the structure of shell, and the embryonic development of purpura, besides his other works on physiology and comparative anatomy. The other Royal Medal has been awarded to Professor J. J. Sylvester, F.R.S., of the Royal Military Academy, Woolwich, for his important contributions to mathematical science. Papers by each of the two last-named gentlemen have appeared in the *Philosophical Transactions*.

TERRESTRIAL MAGNETISM.

A PAPER has been read to the British Association, "On the Secular Changes of Terrestrial Magnetism, and their Connexion with

* *For a Portrait and Memoir of Sir Benjamin Brodie, see Year-Book of Facts, 1859.*

Disturbances," by the Rev. H. Lloyd. It has been generally supposed that, at a given place, the mean yearly values of the magnetic elements were subject to no fluctuations of a minor period; and consequently that, for a limited number of years, the rate of the change of these values from year to year was either uniform, or else uniformly accelerated or retarded. This idea, so far as relates to the magnetic inclination, has been completely disproved by Professor Hansteen. From the long and accurate series of observations of this element, made by himself at Christiana, Professor Hansteen has inferred that the mean yearly value of the inclination is subject to a *periodical fluctuation*, as well as to a progressive change. The length of this period, according to Professor Hansteen, is 11⅓ years; the maxima occurring in the years 1828, 1840, and 1851, and the minima in 1823, 1834, 1845, and 1856. The Dublin observations, so far as they extend, exhibit similar results. If we assume that the inclination decreases from year to year proportionally to the time and compare the results calculated according to this hypothesis with those actually observed, the differences clearly exhibit a cycle or period, whose duration does not differ materially from that laid down by Professor Hansteen. The amount of the periodical part of the variation in 1845—the year of minimum—is so considerable as to mark altogether the regular yearly decrease. The Dublin observations exhibit a similar law in the values of the horizontal component of the earth's magnetic force, as deduced by means of the bifilar magnetometer, combined with absolute determinations made according to Gauss' method. When these results are corrected for the secular change, supposed uniform, they show very clearly the existence of a cycle. The maximum is 3·5071, and occurs in the year 1844; the minimum is 3·5027, and is the mean value of the horizontal intensity for the year 1848. Dr. Lloyd concluded by pointing out the connexion of these phenomena with the periods of greater or less prevalence of magnetic *disturbances*, and showed in what manner the disturbances operated in producing these effects. The general action of a disturbance is to augment the inclination and to diminish the horizontal force; and, accordingly, the year of greatest disturbance should be also that of greatest inclination, and of least horizontal intensity—these elements being supposed to be corrected for the regular progressive change. In the same manner as the easterly disturbances of the magnetic declinations preponderate over the western in this part of the globe, the effect of disturbances should be, on the whole, to diminish the mean westerly declination, which should therefore exhibit a period of the same duration.

General Sabine remarked on the value of this communication as the condensed result of years of laborious research. In his opinion a request should be sent up from the Committee of the Section to the Committee of Recommendations that it should be printed *in extenso* in the next volume of the *Proceedings* of the Association, as justice could not be at all done to it by the abstract laid before the Section.

TERRESTRIAL MAGNETIC FORCES.

THE Astronomer-Royal has read to the British Association a paper "On the Laws of the Principal Diurnal Irregularities, Solar and Lunar, of Terrestrial Magnetic Forces as deduced from Ten Years' Observations at Greenwich, and on their Apparent Causes." The author described in an admirable manner, and suited to the comprehension of all present, what was meant by deviation and diurnal inequalities. Taking, he said, a compass needle or other bar of magnetized iron, if this were freely suspended it would take up a definite position as affected by the earth's attraction. Two forces pulled the needle, one towards the north, the other towards the south. Its position, however, did not remain constant during the day, nor yet during the year; and it was of the utmost importance to register the deviations it made, either by the eye of an observer, or by the far more accurate method of self-registration. The latter method was employed at Greenwich, and was effected by causing a cylinder of sensitive paper to revolve once during the twenty-four hours; on this the beam of light reflected from the needle fell, and made a curved line on the sensitive paper. In a similar manner the amount of force pulling the needle north or south was registered; and thus the horizontal force acting on the needle endways and that acting sideways were rendered visible, and their changes, from time to time, calculated. The common daily disturbing force varied in different years extremely, from 1848 to 1857; and monthly also, for in June and July it was greatest, and in December and January least. This last observation led him to consider that it might depend a good deal on the radiation of the sun's heat, which was greater in summer of course, than in winter. An interesting diagram was exhibited, showing the law of this disturbing force, and consequent deviation of the needle during the day. It was greatest at noon, and decreased from that time till eleven at night, when it was least. The disturbance at the time when greatest tended in a south-westerly direction. He was inclined to explain the fact of this direction being taken from the consideration that Greenwich was peculiarly situated with regard to the distribution of land and water on the face of the globe. During the early hours of the afternoon, the sun, when on the north of the equator, was vertical over a great space of water lying in a south-westerly direction from Greenwich, the radiation from which was very great. Magnetism and galvanism were in his view interchangeable terms; and it was well known that it was difficult to get a galvanic current through the earth at any place on its surface when there was little or no moisture; and thus the sun shining before it reached the meridian of Greenwich on the arid plains of Central Asia, would have less magnetic effect than a few hours later in our day.

General Sabine, in making some observations on the remarks of the Astronomer-Royal, said that he (the Astronomer-Royal) had, in an unusual degree, the happy art of popularizing a scientific and *technical subject.* It required some courage to offer an explanation

of the strange movements of the magnet, and those who studied the subject of magnetism with attention knew that the science was in this state, that they had a great many observations reduced and generalized, and that what was now wanted was a good suggestion to explain them; and the Astronomer-Royal deserves thanks for the one he had thrown out. There was this great objection, however, to the explanation, that the deviations were produced by merely local causes, that we find exactly the same deviations, with small exceptions, at magnetic stations in North America and Tasmania; and even within the Arctic circle, where for three months the sun never appears above the horizon, and where, therefore, no radiation could exist. The Astronomer-Royal, in replying, said that, though it required some courage to make a supposition, it required still more to abandon it, which he was ready to do, if required by facts. He then proceeded to notice those magnetic deviations apparently caused by the moon. His opinion was, that these followed the law of the double tides, having the same epochs. There was a double tide of magnetism every lunar day, following the hours like the tides. There was, however, a considerable discordance in the results obtained for the several years of observation, though this did not destroy their value. No action of the moon as an independent magnet could produce this, and probably the influence was a reflected one from the magnetic earth. He also suggested that it was probable that the moon produced a double tide in the air, and if so in the oxygenic part of it, and they were therefore justified, from the recent discoveries of Mr. Faraday, in expecting a magnetic disturbance twice a day.

MOST ADVANTAGEOUS FORM OF MAGNETS.

To ascertain this has been the object of a series of experiments by Dr. Lamont, of Munich, an account of which, by himself, appears in the form of a translation sent to the *Philosophical Magazine*, by the Astronomer-Royal. Three determinations were required—the magnetic moment, the weight or mass, and the moment of inertia. For this purpose Dr. Lamont procured hardened steel bars of various forms, magnetized them to saturation, and investigated every form by measurement for the above-mentioned determinations. The results are that narrow magnets are more advantageous than broad, thin than thick; and consequently the most advantageous form is that in which breadth and thickness disappear and the magnet is transformed into a mathematical line—*i.e.*, a so-called linear magnet—an imaginary one. Practically, there are two forms which appear advantageous—the flat contracting to a point from the middle, and the flat prismatic. Details are given of six series of experiments, also tables of results, and engravings of the various forms of magnets employed.

TEMPERATURE OF THE EARTH'S CRUST.

MR. FAIRBAIRN has communicated to the Literary and Philosophical Society of Manchester, a paper "On the Temperature of the Earth's Crust, as exhibited by Thermometrical Observations obtained during the sinking of the Deep Mine at Dukinfield." During the prosecution of researches on the conductivity and fusion of various substances, an opportunity occurred of ascertaining by direct experiments, under favourable circumstances, the increase of temperature in the crust of the earth. This was obtained by means of thermometers placed in bore-holes, at various depths, during the sinking of one of the deepest mines in England, namely, the coal mine belonging to Mr. F. D. Astley, at Dukinfield, which has been sunk to a depth of 700 yards. The increase of temperature in descending, shown by these observations, is irregular; nor is this to be wondered at, if we consider the difficulties of the inquiry, and the sources of error in assuming the temperature in a single bore-hole as the mean temperature of the stratum. At the same time, it is not probable that the temperature in the mine-shaft influenced the results. The rate of increase has been shown in previous experiments to be directly as the depth, and this is confirmed by the experiments. The amount of increase is from 51° F. to 57¾°, as the depth increases from 5⅜ to 231 yards, or 1° in 99 feet; but, in this case the higher temperature is not very accurately determined. From 231 to 685 yards, the temperature increases from 57¾ F. to 75½°. This is a mean increase of 1° in 76·8 feet, which does not widely differ from the results of other observers. Walferdin and Arago found an increase of 1° in 59 feet; at Rehme, in an Artesian well 760 yards deep, the increase was 1° in 54·7 feet; De La Rive and Marcet found an increase of 1° in 51 feet at Geneva. Other experiments have given 1 in 71 feet. The observations are affected by the varying conductivity of the rocks, and by the percolation of water.

The author exhibited upon a diagram, in which the ordinates are depths, and the abscissæ temperatures, the results obtained between the depths of 231 and 717 yards. The strata of the mine are also shown in section. Additional to these, the author gave a table of similar results in another pit at the same colliery, taken between the depths of 167½ and 467 yards, and showing an increase of temperature of 1° in 106 feet of descent. Assuming as an hypothesis, that the law thus found for a depth of 790 yards, continues to operate at greater depths, we arrive at the conclusion that at 2¼ miles from the surface a temperature of 212° would be reached; and at forty miles a temperature of 3000°, which we may suppose sufficient to melt the hardest rocks. The author then discusses the effect of pressure and increased conductivity of the rocks in modifying this result. If the fusing point increased 1°·3 F. for every 500 lbs. pressure, as is the case with wax, spermaceti, &c., the depth would be increased from 40 to 65 miles before the fluid nucleus would be reached; but as the same increase is not observed with tin and barytes, the influence of pressure on the thickness of the crust cannot yet be determined. Again, Mr. Hopkins has shown that the

conductivity of the dense igneous rocks is twice as great as that of the superficial sedimentary deposits of clay, sand, chalk, &c. And these close-grained igneous rocks are those which we believe must most resemble the strata at great depths. Now, if the conductivity of the lower rocks be twice as great as that of the strata in which the observations were made, correcting our former estimate, we should probably have to descend 80 or 100 miles, instead of 40, to reach a temperature of 3000°, besides the further increase due to the influence of pressure on the fusing point. On entirely independent data, Mr. Hopkins has been led to conclude that the minimum thickness of the crust does not fall short of 800 miles, in which case the superficial temperature of the crust would have to be accounted for from some other cause than an internal fluid nucleus.

GREAT MAGNETIC STORM.

MR. B. STEWART has read to the British Association a paper "On the Photographic Records given at the Kew Observatory of the great Magnetic Storm of the end of August and beginning of September, 1859." The author remarked that the tendency of this great magnetic storm was to decrease the horizontal and vertical components of the earth's force, and that the disturbing force came in a wave, the period of which was seven hours. He contrasted this lengthened period with that of earth-currents, the period of which is only a few minutes, and supposed that the change in the earth's magnetism is due to the absolute amount of a disturbing force which is of a fluctuating character, and of which the fluctuations produce the earth-currents and Aurora Borealis, which are thus regarded as secondary discharges.

VALUE OF BAROMETRICAL INDICATIONS.

ADMIRAL CATOR has reported to the National Life-Boat Institution that, at Cullercoats, near Shields, in the beginning of October last, the fishermen had expressed to him their gratitude for the barometer which the Duke of Northumberland, president of the Institution, had presented to them. A fearful gale from the westward had about that time somewhat suddenly sprung up. The fishermen were preparing to go to sea. Some of them observed the fall of the barometer, while others disputed its utility and value, and even treated it with derision. The majority of the fishermen, however, decided that they would not go to sea while the barometer was falling, although it was quite fine at the time. A few hours afterwards a terrific gale of wind from off the land came on, when they expressed their firm conviction that every one of them would probably have perished had they gone to sea, as most assuredly they would have gone, in the absence of the barometer.

BALLOON EXPERIMENTS.

COLONEL SYKES has read to the British Association the "Report from the Balloon Committee."

Professor Walker, after the appointment of the Committee at the Aberdeen meeting, having communicated to Colonel Sykes his inability to undertake any active labours with respect to carrying out the objects for which the Committee was nominated, Colonel Sykes put himself into correspondence with Mr. Langley, a gentleman of Newcastle, who offered to construct a suitable balloon, provided an advance of money were made to him. The correspondence, however, was without result, and Colonel Sykes, in consequence, thought it unnecessary to invite the opinions of the other members of the Committee with respect to the objects to be sought for in balloon ascents, as means were wanting, whatever those opinions might be, to give practical effect to them. Colonel Sykes was not at the meeting at Oxford in 1860, and no action having been taken by the Balloon Committee, it dropped through and became extinct. Mr. Simpson, of Cremorne Gardens, having constructed a balloon at a cost of 600*l.* (the Normandie), with a sufficient capacity to carry two persons to great heights, which might be available for the objects of he Association; the occasion had, therefore, arisen when the reappointment of a Balloon Committee might take place; and as one of the chief objects of the last Balloon Committee—viz., the verification of the former results of the ascents undertaken by the authority of the Association—remained unchanged, Colonel Sykes, with the approval of those members of the late Balloon Committee with whom he had an opportunity of conversing, moved the re-appointment of the Committee, with a grant of 200*l.*

THE KEW OBSERVATORY.—THE GREAT SOLAR ECLIPSE OF 1860.

FROM the Report of the Kew Committee to the British Association, we make the following extract, which records the progress that was made in the deeply interesting field of heliography, during the grand Solar Eclipse of June 18, 1860:—

It will be remembered that, at the suggestion of the Astronomer-Royal, the Admiralty had placed at the disposal of the expedition of astronomers H.M. ship *Himalaya*, and that the Government Grant Committee of the Royal Society had voted the sum of 150*l.* for the purpose of defraying the expenses of transporting the Kew heliograph, with a staff of assistants, to Spain. As the scheme became matured, it was deemed desirable to extend considerably the preparations originally contemplated, and actual experience subsequently proved that no provision which had been made could have been safely omitted. Originally it was thought that a mere temporary tent for developing the photographs might have answered the purpose; but on maturing the scheme of operations, it became evident that a complete photographic observatory, with its dark developing room, cistern of water, sink, and shelves to hold the photographs, would be absolutely necessary to ensure success. An observatory was therefore constructed in such a manner that it could be taken to pieces and made into packages of small weight for easy *transport*, and at the same time be readily put together again on the

locality selected. The house, when completed, weighed 1248 lb., and was made up in eight cases. Altogether the packages, including house and apparatus, amounted in number to thirty, and in weight to thirty-four cwt. Besides the heliograph, the apparatus comprised a small transit theodolite for determining the position of the meridian, and ascertaining local time, and the latitude and longitude of the station; and also a very fine three-inch achromatic telescope, by Dallmeyer, for the optical observation of the phenomena of the eclipse. Complete sets of chemicals were packed in duplicate in separate boxes, to guard against failure through a possible accident to one set of the chemicals. Collodion of different qualities was made sensitive in London, and some was taken not rendered sensitive, so as to secure as far as possible good results. Distilled water, weighing 139 lb., had to be included; and engineers' and carpenters' tools, weighing 113 lb., were taken. Mr. Cassella lent some thermometers and a barometer, and Messrs. Elliott an aneroid barometer, to the expedition.

Mr. Beckley and Mr. Reynolds were charged with the erection of the observatory at Rivabellosa; and so well were the plans organized, that the observatory and heliograph were in actual operation on the 12th of July, the expedition having sailed from Plymouth in the *Himalaya* on the morning of the 7th. This could not, however, have been so expeditiously accomplished without the energetic co-operation of Mr. Vignoles, who met the *Himalaya* in a small steamer he had chartered to convey the expedition and their apparatus into the port of Bilboa, and who despatched the Kew apparatus as soon as it was landed to the locality he and Mr. De La Rue had agreed upon. This was situated seventy miles distant from the port of landing, and accessible only through a difficult pass.

The total expenditure of this expedition amounted to 512*l.*; the balance of 362*l.* over the amount granted by the Royal Society has been generously defrayed by Mr. De La Rue.

Upwards of forty photographs were taken during the eclipse, and a little before and after it, two being taken during the totality, on which are depicted the luminous prominences with a precision impossible of attainment by hand drawings. The measurements which have been made of these prominences by Mr. De La Rue show incontrovertibly that they must belong to the sun, and that they are not produced by the deflection of the sun's light through the valleys of the moon. The same prominences, except those covered over during the moon's progress, correspond exactly when one negative is laid over the other; and by copying these by means of a camera, when so placed, a representation is obtained of the whole of the prominences visible during the eclipse in their true relative position. The photographs of the several phases of the eclipse have served to trace out the path of the moon's centre in reference to the sun's centre during the progress of the phenomenon. Now, Rivabellosa being north of the central line of the moon's shadow, the moon's centre did not pass exactly across the sun's centre, but was depressed a little below it, so that a little more of the prominences situated on the north

(the upper) limb of the sun became visible than would have been the case exactly under the central line, while, on the other hand, a little of those on the southern limb was shut off. It has been proved, by measuring the photographs, that the moon during the totality covered and uncovered the prominences to the extent of about 94″ of arc in the direction of her path, and that a prominence situated at a right angle to the path shifted its angular position with respect to the moon's centre by lagging behind 5° 55′. On both the photographs is recorded a prominence, not visible optically, showing that photography can render visible phenomena which, without its aid, would escape observation.

PHYSICAL BASIS OF SOLAR CHEMISTRY.

At the Royal Institution, Professor Tyndall has delivered a lecture on this subject, being a correlation with Professor Roscoe's exposition of the Spectrum observations of Bunsen and Kirchhoff. Professor Tyndall began with a series of experiments by which he demonstrated that gases and vapours radiate and absorb heat in different degrees, and that those gaseous bodies which radiate best absorb best. For example : oxygen, hydrogen, nitrogen, and atmospheric air respectively have the feeblest absorbing and radiating power (about 0·3 per cent.) ; while olefiant gas, the most energetic, absorbs 81 per cent. of the calorific rays. He then showed by means of the electric lamp and the spectrum apparatus that certain gaseous bodies absorb certain groups of rays and leave others unabsorbed, thus producing dark bands in the spectra of the light transmitted through them ; while other gaseous bodies radiate certain groups of rays which appear as separate light bands in their spectra. The bands produced by volatilizing certain metals (mercury, brass, zinc, copper, strontium, &c.) were especially brilliant, each metal having its own system of bands. In the spectra of volatilized compounds the specific bands of each component distinctly appear, and never vary in colour or position. This was shown in the case of volatilized brass, in the spectrum of which the bands of copper and zinc were clearly discernible. These bands, therefore, enable the observer to infer with certainty the metallic vapour by which they are produced (as was proved in the case of sodium, lithium, &c.) Proceeding then to the main subject of the discourse, the Professor reminded his audience that philosophers now consider that all space is pervaded by an elastic medium named ether, which sensibly retards the motion of comets ; that heat and light originate in the vibratory motion of the particles of bodies ; that radiation consists in the transference of this motion to the ether ; and that absorption consists in the transference of motion from the ether to the particles of the absorbing body. The waves generated in the ether by the oscillations of a body's atoms succeed each other in the same periods as the oscillations themselves. When the vibrating atoms of a body excite waves which strike against the atoms of a second body those particular *atoms of the latter* which have the same vibrating period as the

impinging waves accept most motion—the waves which any system of atoms absorb most effectually being those which the same atoms would generate if set in vibration. Now, an incandescent solid or liquid gives a continuous spectrum ; but if the incandescent body be enveloped in a flame this flame will select for absorption those rays of the nucleus which it can itself emit.

In the spectrum produced by this joint light the following effects are possible :—1. If the nucleus be less brilliant than the envelope the bands of the latter will appear bright on the spectrum of the nucleus. 2. If both be of equal brilliancy the quantity absorbed will be equal to the quantity emitted by the envelope, and a continuous spectrum without either bright or dark bands will be given ; but if the nucleus be more brilliant than its envelope the quantity absorbed will be greater than the quantity emitted, and a band, dark in comparison with the adjacent light, will appear at each place, when the envelope alone would produce a bright light. These effects were shown by experiments. "The sun," says Professor Tyndall, "is a body thus constituted. It consists of a solid or liquid nucleus, surrounded by a flaming atmosphere. The spectrum of this atmosphere alone would consist of a series of bright bands, many thousands in number; but the overpowering brilliancy of the nucleus converts these bright lines into lines which are dark in comparison with the adjacent intensely illuminated spectrum." In conclusion, he stated that we are indebted for our present knowledge of the subject to the researches of Euler, Wheatstone, and Miller, but more especially to those of Kirchhoff.

LIGHT AND HEAT OF THE SUN.

MR. JAMES NASMYTH has made a most important discovery respecting the structure of the luminous envelope of the sun. He finds that its entire surface is composed of objects of the shape of a willow-leaf ; these objects average about 1000 miles in length and 100 in breadth, and cross each other in all directions, forming a network. The thickness of this does not appear to be very great, as through the interstices the dark or penumbral stratum is seen, and it is this which gives to the sun that peculiar mottled appearance so familiar to observers. These willow leaf-shaped objects are best seen at the edges of a solar spot, where they appear luminous on a dark ground, and also compose the bridges, which are formed across a spot when it is mending up. The only approach to a symmetrical arrangement is in the filaments bordering the spot and those composing the penumbra, which appears to be a true secondary stratum of the sun's luminous atmosphere. Here these bodies show a tendency to a radial arrangement. Although carefully watched for, no trace of a spiral or vertical arrangement has been observed in these filaments, thus setting aside the likelihood of any whirlwind-like action being an agent in the formation of the spots, as has been conjectured to be the case. The discoverer does not feel warranted at present in hazarding any conjectures as to the nature and functions

of these remarkable willow leaf-shaped objects, but intends pursuing the investigation.

A new determination of the relative brightness of sunlight and moonlight has recently been made by Professor Bond. Hitherto Wollaston's estimate of the sun being equal to 801,072 full moons has been considered the most trustworthy. Professor Bond, however, concluded that Bouguer's ratio of 1 : 300,000 was the more accurate; and upon comparing, by means of Bengal lights, the images of the sun and moon reflected from a silver globe, he came to the conclusion that the sun equals 471,000 full moons. In a similar way it was found that the light of Jupiter was the 1-6430th part of that of the moon, whilst the light of Venus was nearly five times as bright as that of Jupiter.

Professor Kirchhoff asserts that the sun possesses an incandescent, gaseous atmosphere, which surrounds a solid nucleus, having a still higher temperature. By means of an instrument consisting of four large flint-glass prisms and two telescopes he has analysed the light from the sun, and compared it with rays from other sources. He has thus detected the presence of iron in the solar atmosphere, also of chromium and nickel.

An extract of a letter to the Rev. R. Main has been read to the Royal Astronomical Society, on the equality of the polar and equatorial diameters of the sun, in which references were made to several sets of micrometrical measures, principally those of Schroeter. Mr. Carrington, in the discussion which followed, suggested that the action of the sun's heat on the screws, &c., however well guarded against, would still be a source of error, and thought that it was to carefully enlarged photographs that we must look for a demonstration of the real ratio existing between the two diameters. Mr. Pritchard stated that the modern method of observing the sun by means of an unsilvered glass speculum, would appear to be free from the bad effects of the heat mentioned by Mr. Carrington; but Mr. De La Rue stated that in reflectors—the reflected rays being thrown to a point not in the axis of the pencil of incident rays—an elliptical form was given to circular objects, which would, therefore, render reflectors unfit for such observations.

Professor W. Thomson has read to the British Association, "Physical Considerations regarding the Possible Age of the Sun's Heat." The author prefaced his remarks by drawing attention to some principles previously established. It is a principle of irreversible action in nature that, "although mechanical energy is indestructible, there is a universal tendency to its dissipation, which produces gradual augmentation and diffusion of heat, cessation of motion, and exhaustion of potential energy, through the material universe." The result of this would be a state of universal rest and death, if the universe were finite and left to obey existing laws. But as no limit is known to the extent of matter, science points rather to an endless progress through an endless space of action, involving the transformation of potential energy through palpable motion into heat, than to a single finite mechanism, running down like a clock

and stopping for ever. It is also impossible to conceive either the beginning or the continuance of life without a creating and overruling power. The author's object was to lay before the Section an application of these general views to the discovery of probable limits to the periods of time, *past* and *future*, during which the sun can be reckoned on as a source of heat and light. The subject was divided under two heads: 1. On the secular cooling of the sun; 2. On the origin and total amount of the sun's heat. We do not know certainly that the sun is losing any heat at all, and it is certain that *some* heat is generated in its atmosphere by the influx of meteoric matter, and it is possible that the amount thus generated is so balanced as to compensate the loss by radiation. It is also possible that the sun is now an incandescent liquid mass, radiating away heat either primitively created or thus generated by the falling in of meteoric matter. From astronomical considerations, he showed that none of this matter can come from space beyond the earth's orbit; and by considerations derived from the disturbances of the inferior planets and the zodiacal light, the author had shown that the amount of meteoric matter could not be nearly enough to give a supply at the present rate for 300,000 years; and these anticipations have been verified by the recent researches of Le Verrier on the motions of the planet Mercury. Then, from further considerations connected with the motion of comets, he shows that this meteoric matter must be derived from spaces very near to the sun. He then proceeds to estimate how much the sun cools annually, and concludes that it cannot be more than 1°·4 centigrade annually. He then shows, from facts derived from various sources, chemical and astronomical, that the certain limits are entirely inconsistent with some of Darwin's geological estimates of time. Under the second head, the author shows that the statement which he first made still holds, with undiminished force, that meteoric action is not only proved to exist as a cause of solar heat, but it is the only one of all conceivable causes which we know to exist from independent evidence. The reasons for this are again given at length. And he concludes: it is, on the whole, most probable that the sun cannot have illuminated the earth for 100,000,000 years, and certain that it has not for 500,000,000; and as to the future, that the inhabitants of the earth cannot continue to enjoy the light and heat necessary for their existence for many million years longer, unless some sources now unknown to us are prepared in the great storehouse of creation by Him who orders all things rightly and well.

ON SPECTRUM ANALYSIS.

At the late Meeting of the British Association at Manchester, Professor Miller delivered in the Concert Hall, a lecture "On Spectrum Analysis."

The Professor said that the subject which the Council had requested him to bring before them, like the telescope, made known to us what was passing in distant worlds, not only bringing before us

those particular changes which were going on in the bodies which composed our solar system, but appearing further to reveal something of the nature of the more distant starry world. Not only did it thus, like the telescope, make known distant objects, but, like the microscope, it revealed bodies and substances so minute as to defy any other mode of investigation, and which had to the present time defied all the processes of chemical analysis. Like all other great discoveries, it was not the work of a single individual. It was a work in which they were proud to say their own countrymen had borne a prominent part. The spectrum was perhaps the most glorious sight the eye could behold; the beams of white light broken into colours defied description, and could be appreciated only by those who saw it. Having exhibited the spectrum of Newton, the lecturer proceeded by a series of experiments to illustrate the various steps taken in these observations. Fraunhofer examined the light of various fixed stars, and found that although in the sun's light the black lines always occupied a definite position in the spectrum, the black lines in the spectrum of the rays produced by the stars were not always in the same position. This had proved an invaluable fact to opticians in reference to refractive power. Other lights also exhibited a different system of lines. If they heated up any substance until it gave out light, as all solid bodies would if sufficiently heated, these solid bodies would produce an uninterrupted spectrum; but if examined by artificial light there was a broken spectrum, it being crossed by bright lines. Dr. Brewster was the first to throw any light on the cause of these lines. He observed that if the sun's rays were horizontal they had to pass through a stratum of 200 miles or more of atmospheric air at its greatest density; if the rays were vertical they had to pass through one stratum of continually decreasing density. It would be observed that when the sun's rays were horizontal certain portions were absorbed. Hence it appeared that particular rays were caused or deepened by the absorptive action of the earth's atmosphere.

In 1832, Sir David Brewster exhibited to the British Association an experiment in which he had found that red vapours had a remarkable power on the sun's rays. In 1822, Herschel made a series of observations upon coloured lights; and he found that by putting certain salts into the flame of burning bodies those flames became coloured. But it was to Mr. Talbot they owed the suggestion by which these observations could be turned to account for chemical analysis. The colours, in some instances were so closely allied when viewed by the naked eye that nothing could be seen to distinguish them; but the moment they were put through the prism there was a marked and striking difference. Lithia produced a beautiful red colour to the flame; strontia did the same; but the difference through the prism was very apparent. Mr. Wheatstone gave the first impulse to inquiries into the spectra of electric light in 1835. He showed a mass of various spectra produced by sparks taken from different metals. Each metal had its own peculiar spark, which was not due to the burning of the metal, for he had experi-

mented in a vessel from which the air was exhausted, and instead of air had used carbonic acid gas, and found the same result to follow. Each metal had its own spectrum; and, looking at the spectrum, they knew what metal they were handling. Thus they were able, by the lines in the solar and stellar spectra, to ascertain the presence in those bodies of particular metals and acids. Using the spectrum microscopically for analytical purposes, Professor Bunsen discovered, in the residue of a certain spring, a set of lines he had never seen before, and which existed only to the extent of three grains to the ton. This he called cœsium, from its beautiful blue colour. Rubidium had been discovered in a similar manner. Having given specimens of these spectra, the Professor concluded by thanking those gentlemen who had assisted him to make the experiments.

THE PERSISTENT ACTIVITY OF LIGHT.

M. Niepce de Saint-Victor has made some valuable discoveries regarding what he has called the Persistent Activity of Light. He exposed to a bright sunlight, for two or three hours, a piece freshly broken from a slice of an opaque porcelain plate, and afterwards laid it upon paper prepared with chloride of silver. After twenty-four hours of contact, there was a reduction of the salt of silver upon that part which had been exposed to the light, and none upon the remaining portion of the plate. He also ascertained that some kinds of porcelain acquire more easily than others this activity.

A plate of steel, partly polished, and partly unpolished by means of a strong solution of aquafortis, and washed perfectly clean with alcohol, has been dried in the sun under the following conditions:—One half of the polished and unpolished plate under an opaque screen, the other half under white glass. The plate was afterwards covered with paper prepared with chloride of silver albuminized. After twenty-four hours of contact, an impression was obtained upon the unpolished part which had been exposed to the light, but no impression was made upon the polished part of the unpolished portion placed under the screen. Glass treated in a similar manner gave similar results. M. Arnaudon, a chemist of Turin, has repeated these experiments in different gases with the same results as in the open air.

It has often been stated that light will magnetize a bar of steel, but, according to the experiments of M. Niepce de St.-Victor, this is a mistake. He has tried several experiments upon fine needles, but has not succeeded, and concludes, therefore, that this activity of light, illustrated by the preceding experiments, is not owing to electricity or magnetism. From his experiments with magnetized and unmagnetized needles, he concludes that light has no effect upon their electricity.

From all his experiments he concludes that this persistent activity given by light to all porous bodies, even the most inert, is not the same as phosphorescence, as it does not last so long. There is, therefore, most probably, a radiation of light invisible to our eyes—

a radiation which resembles that of gas, as it acts upon, and does not pass through, glass. With light alone, it is impossible either to magnetize or demagnetize any body.

NEUTRALIZATION OF COLOUR.

Mr. F. Field, F.R.E.S., in a paper "On the Neutralization of Colour in Mixtures of Certain Salts," gives the following results:—

Most chemists must have observed that, in the estimation of iron by means of permanganate of potash, the last drop, which shows that the reaction is complete, imparts a rose-red to the liquid, differing somewhat from the bluish pink of the permanganate. The pale yellow of the perchloride of iron has combined with the blue of the permanganate, and the resulting green, not sufficiently powerful to destroy the whole of the red, has left a portion of it visible.

M. Terreil estimates copper by the same reagent. The cupreous salt is deoxidized by sulphite of ammonia, the sulphurous acid expelled by ebullition, and permanganate of potash added until the whole is converted into the protoxide. The difference of tint which the last drop of permanganate imparts to this liquid and to that containing the iron salt, is very apparent. In the case of the copper solution it is nearly blue; in the iron, pinkish red. These facts are not without their significance in qualitative analysis. Gibbs informs us that the beautiful test for manganese, first proposed by Mr. Walter Crum, by the action of nitric acid and peroxide of lead, fails to yield the characteristic tint if nickel be present in large quantity, and the manganese only in minute traces: the nickel salt destroys, or at all events modifies the colour produced by the formation of permanganic acid. If cobalt is present, however, or a solution of salt of that metal is subsequently added, the colour of the nickel is nullified, and that of the manganese becomes sensible.

When red fire, composed of nitrate of strontia, chlorate of potash, &c., is mixed with green fire containing nitrate of baryta and ignited, the red and green rays become invisible, and a white, or rather a bluish-white, flame is produced: the crimson of the strontian flame has a dash of blue in its composition, and the red being removed by the green, is clearly shown. If a rose-red fire be prepared by mixing 34 parts of carbonate of lime, 52 of chlorate of potassa, and 14 of sulphur, or still better, perhaps, 23 of dry chloride of calcium, 61 of chlorate of potassa, and 16 of sulphur, and then ignited with the ordinary green fire, pure white light is produced.—*Philosophical Magazine.*

NEW FALLS OF METEORIC STONES.

Mr. R. P. Greg, of Manchester, writes to the *Philosophical Magazine:* "Some weeks ago I received a letter from Professor Joaquin Balcells, of Barcelona, stating that he had heard of a large Fall of Meteorites, accompanied by tremendous detonations, said to have taken place at Canellas, near Villanova, in Catalonia, at some *distance from* Barcelona, on the 14th of May this year. I have just

received from him another letter dated the 27th of June, enclosing an account of his expedition to Canellas for the purpose of procuring additional information, and also, if possible, some specimens. I give the following translation of this part of his letter:—

'There is no doubt that stones really fell on May 14 at about 1 p.m.; but the greater number are lost, from having fallen with such violence upon the arable land that they could not be found. Two or three fell, however, upon rocks, which they penetrated and cut up to a depth of 5 inches (*pouces*) in a direction towards N.E. at an angle of 45°. They broke into pieces with a tremendous noise and great light. The largest specimen only weighed 18 ounces, and is already destined for the Natural History Museum at Madrid. The second specimen which I saw was destined for the Professor of Physics, Senor Arbá, of Barcelona. I likewise saw other specimens of from 5 to 9 grammes in weight, which were in the hands of the peasants, who would not part with them at any price, because they fancied that these stones, coming from heaven, would bring them good luck. From this cause I was only able to procure for myself one small fragment of 5 grammes weight.' "

An aërolitic fall is mentioned in *Cosmos* for April 26, 1861, as having taken place at Tocane St. Apre, in Dordogne, France; an aërolite fell on the 14th of February, 1861, with a streak of fire (without noise apparently), in the marketplace of that town; it weighed only 7 grammes, and is now deposited in the museum of the department at Dordogne.

Another meteoric stone in all probability fell last year on the 8th or 9th of June, about two miles from Raphoe, in Co. Donegal, Ireland, on the farm of Dr. M'Clintock, of Raphoe, about 2 p.m. It was about the size of a hen's egg, and fell during a storm of thunder, lightning, and hail. It resembled a friable sandstone; but it does not appear there was either any black crust to it, or that there was any fire ball seen at the time. This fall is mentioned in the *Londonderry Sentinel* of June 15, 1860. It appears that one portion of this stone has been lost or mislaid, and the remainder had crumbled into sand and has been thrown away. When it fell it broke into three pieces, and was cold and saturated with wet; it was seen to fall by a ploughman of Dr. M'Clintock's, and immediately afterwards picked up by him.

LIGHTNING FIGURES.

MR. TOMLINSON, of King's College, London, has read to the British Association a paper "On Lightning Figures," chiefly with reference to tho se tree-like or ramified figures sometimes found on the bodies of men and animals that have been struck by lightning. Professor Poey has collected a number of such cases into a memoir, entitled, *The Photographic Effects of Lightning*,—a second edition of which has been published at Paris during the present year. One of these cases is the following:—A boy climbed a tree to steal a bird's-nest; the tree was struck by lightning, and the boy thrown

to the ground; on his breast the image of the tree, with the bird and nest on one of its branches, appeared very plainly. Mr. Tomlinson explains such cases by referring to breath-figures, and showed that when the discharge of a Leyden jar is received on a pane of glass, it burns away a portion of the organic film which covers all matter exposed to the air, so that when breathed upon, the moisture condenses in unbroken streams along the lines where the electricity has passed; while on the other parts of the surface the moisture condenses in minute globules, so that on holding the glass up to the light the figure is distinctly seen, so long as the breath remains on the plate. This figure resembles a tree, bare of leaves, and might (as the President of the Section afterwards remarked with reference to the diagrams exhibited) be taken for any tree in the world. In this figure we have a broad and somewhat rippled line of least resistance or path of the principal discharge, branching off from which are numerous ramifications, from each of which proceed large twigs, and from these smaller ones of great delicacy and beauty. It can be proved that when the discharge of a Leyden jar is thus received on glass, the jar sends out feelers in all directions to prepare the way for the line of least resistance, and this being accurately marked out, the principal discharge takes place. In some cases the discharge bifurcates, and even trifurcates. If the glass presents too much resistance, the breath-figure consists of three feelers only, and these are the lines which produce the sensation of cobwebs being drawn over the face, which seamen sometimes describe as the forerunners of the ship being struck. The main trunk is hollow, and resembles in its structure the silicious tubes known as fulgurites. Mr. Tomlinson took this figure to be typical of the lightning discharge which strikes terrestrial objects, and objected to the stereotyped zigzag by which a stroke of lightning is generally represented. His theory is, that when a tree-like impression is found on the body of a man or animal struck by lightning, a portion of the fiery hand of the lightning itself has passed over the victim and left its mark. Several cases of this kind were described and discussed, but allowance must be made for the imagination of bystanders, which leads them to see in these ramified impressions "an exact portrait of the tree;" the blotches are taken for leaves, for a bird or bird's-nest, &c., as the case may be. Cases were also examined in which these tree-like impressions were referred by medical men to ecchymosis; other cases, in which the impressions of a horse-shoe, of a nail, of a metal comb, of coins, &c., were found on the persons of the victims, were explained on the principle of the transfer of metallic particles from one conductor to another, as illustrated by the well-known experiment of M. Fusinieri. Mr. Tomlinson rejected the photo-electric theory, by which M. Poey attempted to account for the production of all these figures; and in the discussion which afterwards took place, the Astronomer-Royal, Professor Hennessy, and others, were disposed to agree to Mr. Tomlinson's view of the subject.

ON METEORITES.

At the late Meeting of the British Association, the following papers were read :—

Mr. D. Vaughan, in a paper on "Cases of Planetary Instability Indicated by the Appearance of Temporary Stars," endeavoured to explain temporary stars, meteors, and other phenomena, by the approach of revolving planetary bodies to the central in a course of ages, and their breaking up into fragmentary portions. In reference to the speculation, the Astronomer-Royal said that he would not attempt to decide on the possibility or impossibility of events occurring in a course of ages in accordance with those dwelt on by the essayist. Under ordinary circumstances, the preservation of the plane in which a planetary body moved, and the permanency of the eccentricity, were established facts ; but some of the phenomena of the satellites and rings of Saturn showed that it would be hazardous to decide off-hand a subject so very speculative as that discussed in this essay.

Mr. Glaisher read the report of the Committee on Luminous Meteors. He commenced by expressing his regret that so few observations had been made by members of the British Association, and then dilated on the labours of others, especially Mr. Haidinger. The report was followed by a paper by this gentleman—viz., "An Attempt to Explain the Earlier Physical Conditions of Meteorites, as well as some of the Phenomena attending their Fall on our Planet." M. Haidinger, in a paper read on the 19th of April, 1860, spoke of a *typical* form of a meteor, as exemplified in the stone which fell at Stannern, in Moravia, on the 22nd of May, 1808, which on the foremost part appeared rounded off, the crust showing streaks parallel to the probable line of direction through the air, and was much puckered up, like kneaded dough, behind ; and then observed that there must be a starting-point, from some fundamental considerations proved by the phenomena themselves, in order to arrive at an understanding of their forms and conditions. There are, first, the stone leaving the extra-terrestrial space as a solid ; secondly, its velocity being greater on entering the earth's atmosphere ; thirdly, it is retarded by the resistance of the air ; fourthly, the fireball is formed by the compression of the air behind it, and the rotation of the stone resulting therefrom ; fifthly, the termination of the first part of the path is marked by a detention from the so-called "explosion," caused by the collapse of the vacuum from the air rushing in with great violence.

In a paper published by M. Haidinger, we find the following curious calculations concerning Meteorites. Admitting that the weight of these bodies falling annually upon the earth is450,000 lbs., or 450 millions of lbs. in 1000 years, Baron Reichenbach has started the question whether, in the course of centuries, our globe might not undergo such modifications in weight as materially to affect its connexion with the solar system. Now, as our earth weighs about 13¼ quadrillions of pounds, the formation of a meteoric agglomeration equal to our planet would require about 3000 trillions of years : hence any change like that contemplated *by Baron Reichenbach* would occur within a space of time far be-

yond our imagination to conceive. But M. Haidinger turns his attention to another question, asking whether, if our globe in the course of one solar revolution receives an increase of matter equal to 450,000 lbs., this increase might not have been similar in weight in describing any orbit of equal length? Mr. Greg has proved that meteoric falls are less frequent at the time of perihelion than at the time of aphelion; but it must also be recollected that the sun itself moves with considerable velocity through the stellar space. Taking these data into account, M. Haidinger calculates that the weight of meteoric matter existing and moving about in every direction within the space limited by the earth's and sun's motions during one year is equal to 450,000 lbs. multiplied by one billion 218,460 millions, or about half a trillion of pounds. The weight of earth is to 450,000 lbs. of meteorites as 24 millions are to unity; but a far greater proportion of solid matter distributed into small bodies would be obtained, were the great number of shooting-stars and fireballs taken into account, which appear in our atmosphere, and many of which do not apparently deposit solid matter. According to Professor T. H. Newton, of Yale College, U.S., not less than ten millions of meteors of this description enter our atmosphere every day. This would make 3650 millions of shooting-stars and fireballs per annum.—*Galignani.*

THE CLOUD MIRROR AND SUNSHINE RECORDER.

Mr. J. T. Goddard has thus described to the British Association this instrument. The Cloud Mirror was simply a mirror of a circular form with the points of the compass marked on its frame; this being presented face upwards to the sky enabled a person to draw with considerable accuracy at any desirable moment the configuration of the clouds relatively to the horizon and to each other. The Sunshine Recorder was a piece of photographic paper placed in the bottom of a box blackened inside, the top of which had in the centre a small circular hole, through which a slender beam of sunlight could be admitted to pass on to the photographic paper. When the sun did not shine no mark was left on the paper; when it did, its varying diurnal course left a corresponding line on the paper, its position marking the hours of sunshine, and its breadth and depth of shade indicating the greater or less radiating power of the sun.

Professor Airy observed that he had once been shown a very simple sunshine-recorder. It consisted merely of a hollow hemispherical wooden disc, concentric with which was placed a glass spheric lens, whose focal length was made exactly equal to the radius of the wooden disc. As the sun moved along in its diurnal course, the concentrated light and heat burned a corresponding line on the bottom of the disc, more or less intense the brighter or less brightly it radiated, and altogether deficient when it was obscured by clouds.

THE KALOSCOPE.

At the Microscopical Section of the Manchester Philosophical Society, Mr. Heys has read a paper "On the Kaloscope," his newly-invented instrument for the use of coloured light in the examination of objects under the microscope. This the author effects by two sets of four discs each of differently coloured glass, two and a half inches in diameter, mounted on a stand twelve inches high; one set being placed between the light and the bull's-eye condenser, and the other between the light and the mirror underneath the stage, each disc

having an independent motion, so that the light can be transmitted through one or more or both sets at the same time; when the object appears of the colours refracted and reflected through the discs. One of the important uses of the instrument is the protection of the eye from injury occasioned by the use of common artificial light. Many objects which do not polarize, by the kaloscope are made to disclose the beauties of polarized light; for instance, the anthers of the mallow, with their pollen, when viewed by means of red light below the stage, and at the same time green light (the complementary colour) through the condenser, appear of a beautiful green colour on a red or crimson ground. The author observes that some objects, viewed by means of the kaloscope, appear in such relief that they might be supposed to be seen through a stereoscope; these are anthers, jointed hairs, oil-glands, and vegetable sections in general. The calyx of the moss-rose is alluded to, under ordinary illumination, as a mere entanglement of fibres with dark beads; but by this method it is transformed into a stereoscopic branch, with glittering glands at its extremities. Sections of wood, spines of echini, &c., will be found as beautiful as with the polariscope; but, by another arrangement, details are brought out not observable with the latter instrument. A black surface being placed below the stage, coloured light is thrown very obliquely from the mirror, and the complementary colour through the condenser; hairs on the edges of leaves, petals, and filaments of stamens, &c., then appear illuminated by the light of the condenser of one colour, and fringed with the opposite colour on an intensely black ground. The author gives a list of the botanical names of objects advantageously illuminated by this method. A single coloured disc may be also used to advantage with white light from the bull's-eye lens. Details of structure are observable by means of this instrument, which the author observed are inconspicuous without its aid, and thinks that its efficacy in connexion with such a variety of purposes cannot fail to render it of value to the scientific observer.

BINOCULAR MICROSCOPE.

Mr. Beck has exhibited to the Manchester Philosophical Society two of his Binocular Microscopes, on Mr. Wenham's principle; also, a number of first-class objects in various branches of microscopy. The members were much struck with the advantages of the binocular system, which, under low and medium powers, presents the various parts of objects in full relief; they were also pleased with the beauty of certain injected preparations, as brought out by the binocular—such as the eyes of small animals, displaying the clear eyeball, with lenses, cornea, and retina; the smallest blood-vessels were seen to be filled with a bright red and transparent injected fluid—*in situ*—distinctly to be traced and distinguished from each other, instead of appearing, as with the single microscope, a tangled mass, all in the same plane. These instruments and objects strongly mark the rapid advance microscopy is making in the present day.

PANORAMIC LENS.

THIS new instrument has been described to the British Association by T. Sutton. This Lens consisted essentially of a hollow sphere of crystal glass, enclosing water, with a central diaphragm and orifice, so managed as to give equal illumination to the centre and extremities of the panoramic picture, which was received on a screen concentric with the lens. Several photographic pictures taken by it were exhibited, and were entirely free from distortion of figure; what should be straight lines being accurately straight in the pictures, which were stated to extend to an angle of 120°.

Mr. C. Brooke exhibited and explained the construction of the lens, which, he asserted, was rendered perfectly achromatic by a proper adjustment of the surfaces of the glass envelope and the central receptacle for the water. He also exhibited and explained the entire apparatus used with the lens in obtaining the photographic pictures or panoramic views of particular localities. Prof. Chevalier considered that, when the picture which was received on a concentric screen was spread out into a flat picture, the perspective could not be preserved. Mr. Brooke admitted that, mathematically speaking, there was some distortion of the perspective, but it was so trivial as not at all to interfere with the general effect of the panoramic picture. The Astronomer-Royal considered that the obtaining of panoramic photographs of scenes so accurate as those exhibited to the Section, and extending 120° round the observer, was a most important advance in the practical development of photography.

THE DEBUSSCOPE.

A GERMAN natural philosopher, M. Debus, has invented this new form of kaleidoscope, which may be very useful to those engaged in the art of designing patterns. The common kaleidoscope is a tube enclosing two mirrors inclined to each other, so as to give a large number of images. One extremity of this tube is placed in a box which receives a number of small objects, transparent or opaque, coloured or uncoloured; in the other extremity is a hole through which the objects are viewed. The combined images of these objects form regular figures, which are varied with every agitation of the tube and each displacement of the objects. Lately the kaleidoscope was improved so as to present images of natural objects, dead and living, which passed under the eyes of the spectator. The kaleidoscope under both these forms, however, has been only a toy, which was only occasionally used by the designers of embroidery. These mirrors of glass are replaced in the Debusscope by two plates of silver, highly polished, placed vertically, so as to form between them an angle of 45°, at the bottom of a box, which has the form of an elliptical half-cylinder. At the bottom the box has a triangular opening; in front and at the top, the opening is half-oval. By taking any design, regular or irregular, and placing it above the triangular opening of the debusscope, and looking at it through the *upper opening*, the most irregular outline appears transformed into

a regular and beautiful design. The novelty of the debusscope is not simply the substitution of a polished plate for two mirrors, but the arrangement of the apparatus, the idea of reducing the kaleidoscope to two vertical mirrors, and the use of a fixed object instead of small moveable objects. The debusscope may be made of any size. Instead of placing the mirrors in it at a fixed angle, they may be made to move round a vertical hinge, so as to obtain at pleasure any number of images. A graduated arc of a circle placed horizontally upon the apparatus, enables the observer to place the mirrors at any angle, and to reproduce any design. Every change in the apparatus, to the right or left, backward or forward, produces a new design. (See also *Year-Book of Facts*, 1861, p. 122.)

THE RETINA.

SIR DAVID BREWSTER has read to the British Association a paper "On the Optical Study of the Retina." There were two structures in the retina that could be exhibited by optical means, the one by the successive impulses of light, and the other by the action of faint light entering the eye, or produced within it, either from the duration of a luminous impression, or from a local pressure upon the retina. The first of these structures was best seen by the light of a white cloud, through the slits or apertures of a revolving disc, placed midway between its circumference and its centre of rotation, in order to protect the eye from light which did not pass through the slits. When the disc revolved rapidly, the field of view exhibited neither colour nor structure, but merely a diminution of light. When the velocity had reached a certain point, the field of vision became yellowish white, then yellow and bluish. Occasionally the yellow had the form of a rectangular cross, between the branches of which were four dark spaces. With a diminished velocity, the whole field became uniformly blue, and was now covered with the hexagonal patterns formed by deep black lines, the lines being darker at the place of the *foramen centrale*. As there were no fewer than eight different layers in the retina, and it was of great importance to ascertain the functions which they individually performed in conveying visual impressions to the brain, it was only by optical means that this inquiry could be conducted. The anatomist had ably performed his part with the aid of the microscope, and it was probably from the improvement of this instrument chiefly that we could expect any further discoveries, unless the morbid anatomy of the retina should connect certain imperfections of vision with the condition of certain layers of the membrane. When the eye was left in darkness, by the sudden extinction of a light, there were several points at the margin of the retina which retained the light longer than the rest. There could be no doubt that these effects were produced by structural differences. In the case of the *foramen* the difference had been recognised by the anatomist, and was proved by the remarkable phenomena of Haidinger's brushes, and by other optical facts, such as the in-

stability and superior brightness of oblique impressions on the retina. We had, consequently, an optical principle which enabled us to explain the quadrangular structure he had described. It was not improbable, when we looked at the complete structure of the retina, and even of its individual layers, that the structure of each of them might be exhibited optically.

PHOTOGRAPHIC MICROMETER.

Dr. Thomas Woods, of Parsonstown, has been engaged in making experiments to get a glass slide for a microscope marked so as to measure very minute objects; and as his Micrometer (measuring $\frac{1}{100}$th of an inch) was useless for the purpose he had in view, it occurred to him that by the diminishing power of the camera he might succeed in obtaining smaller divisions. He tried first for pictures of dark lines, $\frac{1}{18}$th of an inch in breadth, on a white ground, reduced to a small compass, but he did not succeed even with a very small aperture to the lens. He then substituted lines $\frac{1}{4}$th of an inch in breadth removed to a greater distance, and he got a pretty sharp picture; but he found that the sharpest and best-marked picture of distant lines he obtained was given by opaque bars, placed so that the light from a clear sky came to the camera between them.

By nailing rods of blackened wood, $\frac{1}{4}$th of an inch broad and $\frac{1}{4}$th of an inch asunder, across a frame, and placing this at a suitable distance with a clear light behind, and using an aperture of about $\frac{1}{8}$th of an inch in diameter, he easily obtained well-marked and sharp lines the $\frac{1}{1000}$th of an inch apart and the $\frac{1}{1000}$th of an inch in breadth, sufficiently accurate for all the purposes of a micrometer. The picture of the lines requires to be covered with transparent varnish to prevent rubbing. Dr. Woods has taken the picture on very thin talc, and cemented it to glass with the collodion between the plates, and for object-glasses of small power, it has been found to answer; but the thickness of the talc is too much for the higher powers, as the object viewed and the lines do not sufficiently agree in focus.

Dr. Woods supposes the reason why lines with spaces between them give a better picture than black lines ruled on a white ground is, because there is no irradiation of light from behind, at least not nearly so much from the spaces as from the white ground. At all events, whatever the cause may be, the lines with the spaces give a much better and sharper impression.

The picture of the lines should be a positive one, and very clear. The collodion prepared with the iodide of iron, according to the formula given in the *Philosophical Magazine*, July, 1854, acts admirably. It must be very sensitive, on account of the smallness of the aperture necessary for the required sharpness.

No doubt, much finer lines than these might be obtained by the same process.

CELESTIAL PHOTOGRAPHY.

MR. WARREN DELARUE, in his Report to the British Association, "On the Progress of Celestial Photography since the Meeting at Aberdeen," says, some curiosity naturally exists as to the possibility of applying photography to the depiction of those wonderful bodies, the comets, which arrive generally without anything being known of their previous history, and absolutely nothing as to their physical nature. It would be valuable to have photographic records of them, especially of their nucleus and coma, which undergo changes from day to day; and hence such a means of recording their changes as photography offers would be the best beyond comparison, if the light of the comet were sufficiently intense to imprint itself. On the appearance of Donati's comet in 1858, I made some attempts to delineate it with my reflector on a collodion film, but without success; and on the appearance of the comet of the present year, I made numerous attempts, not only with my telescope, but also with a portrait camera, to depict it, but even with an exposure of fifteen minutes (minutes, not seconds), I failed in getting the slightest impression, even with the portrait camera. Hence, this conclusion may be arrived at, that the actinic ray does not exist in sufficient intensity in such a comet as the last to imprint itself, and, therefore, photography is inapplicable to the recording of the appearances of these wonderful bodies. I have obtained some sun-pictures of very considerable promise on the extremely large scale of the sun's diameter, equal three feet. These pictures have only been very recently procured, and I submit them because I believe that an interest is felt in the progress of celestial photography, and that our members prefer to take part in the experiments, as it were, by watching their progress, rather than to wait until the most perfect results have been brought about. The mechanical and chemical difficulties have been surmounted, and the only outstanding one is the form of the secondary magnifier. When this has been worked out, perfect sun-pictures three feet in diameter will be obtainable with a telescope of one foot aperture in less than the twentieth of a second of time. These pictures, when taken under suitable circumstances, may be grouped so as to produce stereoscopic pictures, which must throw considerable light on the nature of the spots. It appears to me that such results must be of value to science, and that such records of the state of the sun's photosphere, both as regards spots and other changing phenomena, which are obtainable by means of photography, are worth collecting and discussing. Several photographs were handed round to the audience during the reading of the paper.

In the conversation which followed Dr. Robinson pointed out the advantages to science likely to result from these researches; and concluded by suggesting that a suitable sum of money be placed at Mr. Delarue's disposal for the continuance of these researches, and that still Mr. Delarue would afford what money could not purchase—his own invaluable superintendence and cooperation. The Astronomer-Royal, after heartily concurring in the suggestion of Dr. Robinson, called the attention of the Section to the

large photograph of the sun, and especially to the rapid shading off of the intensity of the light towards the outside of the sun's disc. He and the late M. Arago had differed on this very point; M. Arago maintaining that the intensity of the sun's light must increase towards the edge of the disc; while he, the Astronomer-Royal, ventured to maintain the contrary opinion. Here, by this very ingenious process by which Mr. Delarue had succeeded in photographing the sun's disc, it became palpable that his opinion was in accordance with the fact in nature; while that of M. Arago cannot any longer be maintained. The photographed fact settles the question.

THE APPLICATION OF PHOTOGRAPHY TO THE MICROSCOPE

Is strongly advocated by Professor O. M. Rood in *Silliman's American Journal of Science*. He gives a drawing of his apparatus and directions for illuminating the object, focal adjustment, the preparation of the collodion, &c. Living organisms offer the most difficulty to the photographer by their constant motion. Dr. Rood describes his plan for throwing the image on the sensitive plate the very instant after the animalcule has been brought into focus. The subject is one of growing interest.

RADIATION AND ABSORPTION OF HEAT, AND LUNAR RADIATION.

Professor Tyndall, in a letter to Sir John F. Herschel (in the *Philosophical Magazine*), in reference to the researches of the latter on Solar Radiation; the Professor stating that he has been for some time experimenting on the permeability of our atmosphere to radiant heat, and that he arrives at the conclusion that true air—*i.e.*, the mixture of oxygen and nitrogen which forms the body of our atmosphere—is, as regards the transmission of heat, a practical vacuum. The results from which the opacity of air have been inferred are all to be ascribed to diffused extraneous matters, and mainly to aqueous vapours. On Oct. 10 last, he found the absorptive action of the common air in the laboratory of the Royal Institution, London, to be made up of three components—the first, due to the pure air, being represented in magnitude by the number 1; the second, due to the transparent aqueous vapour, by the number 40; and the third, due to effluvia of the locality and the carbonic acid of the air, by the number 27. The total action of its foreign constituents was certainly 67 times that of the atmosphere itself, while the aqueous vapour alone exerted an action at least 40 times that of the air. On Oct. 18, Professor Tyndall made a series of observations on the moon from the roof of the Royal Institution. From six concurrent experiments, he says:—"I was compelled to infer that my thermo-electric pile lost more heat when presented to the moon than when turned to any other portions of the heavens of the same altitude. The effect was equivalent to a radiation of *cold* from our satellite.

I was quite unprepared for this result, which, however, you will at once perceive may be an immediate consequence of the moon's *heat.* On the evening in question a faint halo which surrounded the moon, and which was only visible when sought for, showed that a small quantity of precipitated vapour was afloat in the atmosphere. Such precipitated particles, in virtue of their multitudinous reflections, constitute a powerful screen to intercept the terrestrial rays; and any agency that removes them and establishes the optical continuity of the atmosphere must assist the transmission of terrestrial heat. I think it may be affirmed that no sensible quantity of the obscure heat of the moon, which, when she is full, probably constitutes a large proportion of the total heat emitted in the direction of the earth, reaches us. The heat is entirely absorbed in our atmosphere, and on the evening in question it was in part applied to evaporate the precipitated particles, hence to augment the transparency of the air round the moon, and thus to open a door in that direction for the escape of heat from the face of my pile. The instrument was furnished with a conical reflector, the angular area of which was very many times that of the moon itself."

The following details of the observations are interesting. Professor Tyndall observes :—

My place of observation was the roof of the Royal Institution in Albemarle-street, where I had a platform erected, sufficiently high to enable me to sweep a large portion of the heavens with my thermo-electric pile, without impediment from the chimney-pots. Wires were carried from the pile to an excellent galvanometer placed in the laboratory, the floor of which was about seventy-two feet below the platform.

On directing the axis of the pile towards the heavens, the chilling produced by radiation from its exposed face was so considerable, and the consequent galvanometric deflection so great, that it was quite hopeless to operate on the needle in this position. To move it a single degree would have required many hundred times the quantity of heat or cold necessary to urge it through one of the lower degrees of the galvanometric scale; I therefore operated as follows :—

The galvanometer was a differential one; that is to say, two wires ran side by side round the astatic needle of the instrument. The ends of one of these wires were connected with the pile on the roof, the ends of the second wire were connected with a second pile, which was turned towards a vessel kept at a constant temperature by boiling water. The direction of the current caused by the heat below was opposed to that generated by the cold above; one of them in a great measure neutralized the other, and the needle was thus compelled to take up its place among the lower degrees of the scale.

I then ascended to the roof, fixed my pile at the proper angle, and directed it *off* the moon; I descended and observed the galvanometer; the needle oscillated between 10° and 20°, its mean position being therefore 15°.

I reascended and turned the pile *on* the moon; on descending I found the needle oscillating between 35° and 45°, the mean position being 40°.

The ascending and descending was repeated six times, and the following results were obtained :—

Mean deflection.	
Off the Moon.	On the Moon.
°	°
15	40
27	40
33	40

These numbers all show *cold*, the deflection being such as would be produced by the cooling of the face of the pile presented to the heavens; and the result is that *the chilling was in all cases greatest when the pile was directed towards the moon.*

The explanation given of this result in my letter to Sir John Herschel, I think, deals with a true cause. One hot body may, I think, be chilled by the presence of another in virtue of an action on the intervening medium. But whether the cause is *sufficient* may admit of question. It would not be sufficient if the height of our atmosphere were restricted to the limits which many assign to it. But if I understood the Astronomer-Royal aright at Manchester, there is some reason for supposing the atmosphere to extend immeasurably beyond those limits. But then its extreme tenuity at great distances would probably be urged against the possibility of its producing any sensible effect. Tenuity in the abstract, however, hardly furnishes a sufficient argument. In a very few weeks I shall have occasion to show that the action of a stratum of vapour three feet thick, and possessing a tenuity which amounts only to a fraction of that assigned to our atmosphere at a height of eighty miles, is capable of accurate measurement. Nevertheless it would be a mere game of intellectual gymnastics to continue such speculations as these; for reflection on observations made before and since the publication of my letter to Sir John Herschel, leads me to conclude that in the atmosphere of London it is perfectly hopeless to obtain trustworthy results on this very delicate question.

For example, my place of observation was Albemarle-street, and my pile when turned on the moon looked nearly due south. The reflector of the instrument thus cleared in a great measure the buildings of Lambeth. I turned the instrument eastward, through a large arc, but in so doing came more over the mass of London. This *may* account for the diminished loss of heat. But even this, though apparently a natural one enough, I should hesitate to assign as the real cause of the result observed. Fresh experiments, under different conditions, will be required to decide the question.

I may add that I have furnished the pile with a conical reflector of polished tin of vast dimensions, hoping thereby to collect, not only the moon's luminous rays, but also her obscure rays, which even if they reached the earth, were effectually cut off by the polyzonal lens which Melloni used in his experiments on the moon. To protect the exposed face of the pile from currents of air, I have had the reflector furnished with screens of rock-salt. But these precautions led to no satisfactory result, the irregularities of the London atmosphere producing disturbances of the galvanometer far more than sufficient to mask the effect of the moon's rays.

MANUFACTURE OF ICE.

M. Carré proposes to obtain Ice by a simple process in the hottest summer. He takes two strong iron bottles, connected together with an iron pipe, and nearly fills one with a concentrated solution of ammoniacal gas in water. After connecting the bottles together, and making the joints secure, the one containing the ammonia is put over a fire, whilst the other dips into water. The action of heat upon the ammonia drives off the gas, which, not being able to escape, condenses under the enormous pressure in the other bottle as a liquid. When this is effected, the bottle is removed from the fire and cooled, whereupon the ammonia in the second vessel rapidly assumes the gaseous form, and abstracts so much heat from the water by which it is surrounded as to freeze a considerable quantity. The operation may be repeated without disconnecting the retorts, until a sufficient amount of water is frozen. Ice made in this way is said not to cost more than fivepence a hundredweight.

CAPILLARY TUBES.

At the Manchester Literary and Philosophical Society, Mr. *Crompton has* exhibited specimens of Capillary Tubes used by him

to collect and preserve fluids for microscopical examination for medical purposes. Mr. Crompton has used such tubes for more than a year, and has preserved specimens of blood, urine, &c., which by any other method would have spoiled. The main feature consists in hermetically sealing the tubes after the introduction of the fluid, by holding their ends alternately in the flame of a candle or lamp until the glass melts, and the orifice closes; the tubes may be about three-fourths filled by capillary attraction or immersion, and care must be taken not to allow the fluid to approach the hot end of the tube whilst being sealed. The Edinburgh vaccine tubes answer the purpose well; they may be about three inches long, and a number of them may be carried in a small pocket-case at all times ready to be filled. When required for examination, the tube is broken, and the enclosed fluid placed under the microscope.

PATH OF A PROJECTILE.

A PAPER has been read to the British Association "On the Apparent Path of a Projectile, as affected by the Rotation of the Earth," by the Rev. Prof. Price. This communication, though in its details eminently mathematical, yet conducted to conclusions, some of which had an important bearing on the directing of missiles discharged from some of those new guns which in some cases gave them destructive powers even at ranges of 10,000 yards, or nearly six miles. The author explained to the mathematical part of his audience the symbols which he used and the successive integrations by which he arrived at the more general results, and the approximations by which these became so simplified as to be applicable to practical uses, these approximations chiefly depending on the very small fraction which expresses the angular velocity of the earth per second—a fraction which, when expressed decimally, has four ciphers after the decimal point before the first significant figure is arrived at, and whose square, therefore, and higher powers are too small to be of any practical value. He thus arrived at simple linear equations, which were easily integrated, and thus the path of the projectile obtained with sufficient exactness for all practical purposes. He selected two useful examples—one where the initial velocity was nothing, as in the case long ago investigated by Hook, of a stone dropped from the hand into a deep mine, or from the top of a high tower, the path turning out to be a cubical parabola, showed a deviation to the east with a very small deviation to the south, from the point immediately beneath that from which it had been let drop, as actual experiment had determined it to be long since. The other example selected was that of a gun, directed due north or due south, in either case a westerly deviation being indicated, so that a gun of long range being directed exactly to its object the ball would never strike that object. He also stated, that at every rhomb along which the gun was directed, a deviation peculiar to that point of the compass was indicated by the formula.

DISCOVERY AS TO SPIRALS.

It is a well-known fact that certain plants tend to Spiral action, some to the right, others to the left. We are of opinion that a new light will be shed upon these tendencies by a discovery announced to the Royal Society. The discovery referred to has been made by Professor Wiedemann in a series of interesting experiments on the magnetization of iron and steel. The professor has discovered that, if an iron wire be twisted during, or even after, the passage of a voltaic current through it, the wire becomes magnetic. When the wire is twisted in the manner of a right-handed screw, the point at which the current enters becomes a south pole, in the opposite case it becomes a north pole. If, during the passage of the current, the wire be twisted in opposite directions, the polarity changes with the direction of the twist; if it be twisted in opposite directions after the interruption of the current, the magnetism produced by the first twisting rapidly diminishes.—*Builder.*

CONSERVATION OF FORCE IN ORGANIC NATURE.

Prof. Helmholtz has read to the Royal Institution a paper "On the Application of the Law of Conservation of Force in Organic Nature." The first part of his lecture was devoted to the exemplification of the correlation of the physical forces in the inorganic world, or, as the lecturer thought it might be better called, the "conservation of energy," as it was not intensity of force, but the expression comprehended the whole amount of power which could be gained by any natural process. If two chemical elements influence each other, a force will be exhibited which can be expressed by an equivalent foot-measure, *i.e.*, by a stated comparison with the known weight required to raise a cubic foot of water a foot in height. When any force employed has once effected an alteration, it has lost all faculty for doing so a second time. Still the force is not destroyed; there is always another force, or phase of force, equal to the force which has disappeared. The force employed is not exhausted, nor is it increased—it is merely changed. Take, first, gravity. The universe and machinery alike show it as a power or force. Clocks are put into motion by a weight. In the same way mills are worked by falling water; in short, by a falling weight every machine can be put into motion, and every kind of machine-work done. But when the weight has once fallen to the earth, it has still the same gravity, but its power is exhausted; it must be raised again before it can do more work. By the force of a falling weight we can raise another weight. By the falling weight of water on a mill-wheel, a hammer can be raised, and we can estimate the work done by the hammer in foot-power; but the amount of work the hammer can perform cannot exceed the original power of the weight of falling water, and the height through which it falls.

Velocity is another form of mechanical power. A bullet shot off from a gun with a high velocity has great power of destroying; if

its velocity be lost, it is a harmless little thing. Velocity of the air —wind—is a motive power. It drives our windmills, and is efficient for every kind of mechanical work. Take a pendulum, raise it to one side, release it. It falls to the point of equilibrium; by the *vis viva*, or velocity, it ascends to the other side until its velocity is changed into elevation of weight, and so on. By the velocity of a bent spring watches are moved, so likewise the cross-bow bent, becomes a reservoir of power; the force communicated by the human hand is given out slowly in the watch, suddenly in the cross-bow, so that the whole force is transferred at once to the bolt. So elasticity of air gives velocity, as in the air-gun. The elasticity of compressed gases gives motive power to our mightiest engines, and there we have a different case: the compression of the vapours is effected, not by the human hand, but by heat; the heat, again, is produced from fuel—so heat is a motive force, and the connexion of heat and motive power is a subject of great importance in the study of the conservation of vital force. If heat produces mechanical work, so heat can be produced by mechanical means—by percussion, friction, &c. Iron can be brought to glowing redness by continued hammering. The amount of mechanical work done by heat can be estimated in foot power, and if we wished to regain the heat expended, we must apply the same amount of mechanical work as has been performed. Just as the last source of motive power is traceable to the heat emanated by the fuel, further examination shows that the emancipation of the heat is due to the chemical forces, which thus are shown to be also sources of motive power.

In every case, however, we see that in nature the amount of power or force we employ is neither increased nor diminished in any changes produced or mechanical work done. Whatever force may be originally employed, its exact equivalent remains in some way or other in the results. It may be divided, or combined, or accumulated; but it is neither more nor less. So palpable is this, that it would seem that the amount of force or energy primarily given to the whole universe was the same as now exists and maintains it in order. Suppose the first universe a chaotic mass of material substances in infinite space, the same energy which raised the weight, afterwards aggregated the nebulous vapour into solid globes. The energy of attraction being thus destroyed by the law of conservation of force, heat was evolved, and thus we may perceive that the amount of force employed in the conglobation of the sun surpasses all limits of comprehension, as the most moderate calculations that can at present be made would give an evolution of heat from the sun at its first condensation 28 millions of degrees greater than the quantity it now radiates into space, and the degree of intensity of the present heat of that orb may be gathered from the recent observations of Kirschoff and Bunsen, which have proved the presence of the incandescent vapour of certain metals in the sun's photosphere.

If we turn to our earth it still contains some of the primitive energy in the form of internal heat, which, however, has not now much influence upon its surface, the small quantity now conducted

there not being capable of raising the temperature more than the 1-13th part of a degree.

In the gravitation of the sun and moon we have motion produced on the face of our globe; and another source of motion comes to us in the rays of heat with which the sun's beams are charged: by these some parts of the atmosphere are raised, and winds, vapours, and meteorological phenomena produced.

The light of the sun is, moreover, the cause of another phenomenon: plants can only grow by its means. By the aid of sunlight they can produce inflammable matter, and deposit it in those tissues which, by its agency also, they have extracted from the carbonic acid and water in the earth and air. This phenomenon gives the first insight into the conservation of organic force.

Meyer, guided by these considerations of the correlation of the physical forces, first deduced, in 1842, the general principles of the conservation of organic force, in which he was followed, in 1855, by Professor Helmholtz. For machines there is necessarily a motive power. The machinists of the last century, unaware of the law of conservation of force, sought to find out perpetual motion, and they thought they had examples in the bodies of every animal where motion seemed produced every day without any supply of mechanical power. Compare, then, living bodies with a steam-engine (and the comparison is accurate); they take in food—the equivalent of fuel—in the form of inflammable substances, as fat; hydro-carbons, as sugar; nitrogenous substances, as albumen, flesh, cheese, &c.; and so also they take in, by respiration, oxygen.

Living bodies give off, like the steam-engine, the products of combustion. Suppose we weigh an animal on two occasions, and find it exactly the same weight. In the interim the animal must have taken in food and oxygen, and have given out carbon, nitrogen, and urea; therefore, certain quantities of materials have been combined with oxygen, and have produced the same results which would have been produced in an open fire, with this only difference, that oxidation goes on slowly in the human body. For the amount of work to be done, it is immaterial how the process goes on; the amount of work is the equivalent of the chemical process or combustion performed. When an animal is reposing heat is produced, and its quantity is equal to the quantity of food digested, or to the amount obtainable by burning that quantity of food. Experiments to prove this are difficult to make, but they have been attempted, and the results obtained are within one-tenth of absolute correctness.

If the body be not reposing, its muscular exertion is the equivalent of mechanical work. There are many different kinds of muscular work, but the greatest amount of muscular or mechanical work is performed on the treadmill, or in going up a hill, in which the whole weight of the body has repeatedly to be raised—in the latter case to ascend the declivity, in the former because the hill, so to speak, or the treadmill, is constantly going down under the feet. In ascending a hill, the respiration is greatly increased, and is far greater than arises from muscular exertion on a plain. It would appear

that in such muscular action more force or energy is excited by the increased decomposition of the body than is required for the mere mechanical work performed, and that sometimes as much as four-fifths pass off in the form of heat.

So, also, electricity can be changed into mechanical work, but in this, as in all other cases, the work performed is only equivalent to the force applied. The philosophers of the last century thought that the vital principle was antagonistic to inorganic laws, and, by suspending their actions, maintained the body in life and health ; but it has been reserved for the present generation to show that the same laws of physical force, which are indissolubly linked and correlated in the inorganic world, are also the mainspring of the wonderful actional properties of life, and that from chemical and destructive changes the source of the mechanical powers of animated beings is obtained, and which force or energy is never destroyed or obliterated ; all organic nature being, equally with inorganic, subjected to one universal conservation of force.

MOLECULAR THEORY OF ORGANIZATION.

PROF. BENNETT, M.D., has communicated a paper on this subject to the Royal Society of Edinburgh. Parodying the celebrated expression of Harvey, viz., *Omne animal ex ovo* (says the Professor), it has been attempted to formularize the law of development by the expression, *Omnis cellula e cellulâ*, and to maintain 'that we must not transfer the seat of real action to any point beyond the cell.' In the attempts which have been made to support this exclusive doctrine and to give all the tissues and all vital properties a cell origin, the great importance of the molecular element, it seemed to the author, had been strangely overlooked. It becomes important, therefore, to show that real action, both physical and vital, may be seated in minute particles, or molecules much smaller than cells, and that we must obtain a knowledge of such action in these molecules if we desire to comprehend the laws of organization. To this end the author directed attention: 1st, to a description of the nature and mode of origin of organic molecules ; 2nd, to a demonstration of the fact that these molecules possess inherent powers or forces, and are present in all those tissues which manifest vital force ; and 3rd, to a law which governs the combination, arrangement, and behaviour of these molecules during the development of organized tissue.

REGENERATION OF BONE.

DR. DEMEAUX has communicated to the Paris Academy of Sciences a paper "On the Regeneration of Certain Bones of the Face by the Mucous Periostic Membrane." Our readers know that the larger bones have been successfully renewed by preserving the periosteum, as has been done by Drs. Sédillot, Maissonneuve, and others, but instances were wanting of a similar regeneration of the facial bones. Dr. Demeaux relates the following case: A young man, aged 22,

was in 1855 afflicted with a naso-pharyngian polypus of extraordinary size, which had seriously injured the face, and destroyed a portion of the palate bone on one side, so that the tumour protruded into the cavity of the mouth, being only separated from it by the mucous membrane, which had even been considerably thinned. The tumour was extirpated, and it was then ascertained that a surface of 15 square millimètres at least was wanting in the bone. Six years later Dr. Demeaux met his patient again, and found that the bone had been completely regenerated. The second case stated by Dr. Demeaux is still more curious. In October, 1859, a young soldier of the army of Italy returned to France after a long stay in the military hospitals. He had been hit at Solferino by a musket-ball, which had fractured the upper maxillary bone on the left side. On the following day the surgeon had extracted the projectile, a great many splinters of bone of various sizes, three molars, and the portion of maxillary bones in which they were inserted. When this young man was examined by Dr. Demeaux, about one-half of the roof of the palate was deprived of its bone, and the mucous periostic membrane was the only separation existing between the nose and the fauces, a circumstance which materially impeded the patient's speech and power of deglutition. In the summer of 1860, when Dr. Demeaux saw him again, the palate, as well as the other missing bone, were found to have been completely regenerated.—*Galignani.*

HEARING WITH TWO EARS.

M. PURKYNIE has communicated to the Bohemian Society of Sciences some interesting experiments upon the perception of sound by the Ear. Two India-rubber tubes formed at one end into a hearing trumpet were introduced, one into each ear, and two persons spoke at the same time into the two trumpets. Some time always elapsed before it was possible to distinguish the words on either side, or even on both sides at once. When the tubes had several branches, so that more than two persons could speak at once, it was impossible to understand their words. When two tubes were united into one trumpet, the sound of the voice was heard always as if it existed inside the head, upon whatever side the person speaking was placed. By this means we might examine the relative sensibility of the two ears, for, when they differ, the sound appears to reside in the head nearer one ear than the other. M. Purkynie thinks that the illustration in question may be explained by the structure of the auditory conduit and of other parts of the organ of hearing. With two tubes communicating with the two ears, M. Purkynie could not succeed in associating two vowels so as to hear a diphthong. But by adapting to one ear a tube with two branches, each vowel associated easily with every other, and diphthongs were heard perfectly. In the same way two sounds, such as *s* and *a*, *f* and *a*, &c., might be confounded in syllables. Two musical sounds, when heard by the tube, produced a third tone by combination, which appeared to have its seat in the inside of the head.

DEEPEST WATER AROUND THE BRITISH ISLES.

A PAPER has been read to the Geological Society, "On the Lines of Deepest Water around the British Isles," by the Rev. R. Everest. By drawing on a chart a line traversing the deepest soundings along the English Channel and the eastern coast of England and Scotland, continuing it along the 100-fathom-line on the Atlantic side of Scotland and Ireland, and connecting with it the line of deepest soundings along St. George's Channel, an unequal-sided hexagonal figure is described around the British Isles, and a pentagonal figure around Ireland. A hexagonal polygon may be similarly defined around the Isle of Arran. These lines were described in detail by the author, who pointed out that they limited areas similar to the polygonal form that stony or earthy bodies take in shrinking, either in the process of cooling or in drying. The relations of the 100-fathom-line to the promontories, the inlets, and general contour of the coast were dwelt upon; and the bearings that certain lines drawn across the British Isles from the projecting angles of the polygon appear to have on the strike and other conditions of the strata were described. After some remarks on the probable effect that shrinkage of the earth's crust must have on the ejection of molten rock, the author observed that, in his opinion, the action of shrinking is the only one we know of that will afford any solution of the phenomena treated of in this paper, namely, long lines of depression accompanied by long lines of elevation, often, as in the case of the British Isles, Spain and Portugal, and elsewhere, belonging to parts of huge polygons broken up into small ones, as if the surface of the earth had once formed part of a basaltic causeway.

DEPTH OF THE SEA.

MR. C. W. SIEMENS has described to the British Association the Bathometer, an instrument to indicate the Depth of the Sea without submerging a line. The sea-water being considerably less in density than the rocks which constitute the crust of the earth, Mr. Siemens showed by considerations derived from the integrals expressing the attractive force of any shell of the crust of the earth, that the depth of water under a ship must vary the total attractive force of the earth to such an amount as would become sensible to a very sensitive instrument. He, therefore, devised one consisting of a body of air enclosed in a strong glass cylinder made to support, by its elasticity, a column of mercury contained in a tube open at the bottom and dipping into it, kept at a uniform temperature by being surrounded by melting ice. The tube containing the mercury ends in a ball above, from which rises another tube and ball, the upper ball being still continued into a similar tube. Above the mercury, which rises to the middle of the lower ball, oil of juniper is put until it reaches the middle of the upper ball, and then coloured weak spirit is placed above the oil. The length of the column of mercury may be considered as a measure of the total gravitation of the earth, and the variations of this length are rendered very sensible by the dif-

ferential apparatus, consisting of the two balls, and read off on a scale of about three inches length attached to the tube rising from the upper ball. The instrument hangs in the cabin of the ship. Her Majesty's Government were kind enough to send a vessel with the author and the instrument to the Bay of Biscay to make experiments with it, and its indications of the depth of water under the ship were found to be within less than 10 per cent. from the truth as determined by the lead.

THE MILKY SEA.

At the Paris Academy of Sciences has been read an extract of a report from Captain Trebuchet, of the *Capricieuse* corvette, dated Amboyna, August 28, 1860, in which he states that on the night of the 26th of that month, while tacking to reach Amboyna, lying at about twenty miles E.N.E., he and his crew witnessed the curious spectacle of the *Milky Sea,* which the Dutch call the *Winter Sea,* because both the sky and the waters present the appearance of fields covered with snow. The phenomenon lasted from 7 p.m. until the return of daylight. They at first attributed it to the reflection of the moon, then only three days old ; but, as the appearance continued after the moon had set, this explanation had to be discarded. A bucketfull of sea-water being drawn up and examined, it was found to contain about 200 groups of animalculæ of the same thickness (that of hair), but of different lengths, varying between one and two-tenths of a millimètre, and adhering to each other by tens and twenties, like strings of beads. These insects emitted a fixed light similar to that of the firefly or glowworm, and it was admitted on all hands that the white appearance of the sea could only be attributed to these minute creatures, the numbers of which must therefore exceed all imagination.—*Mechanics' Magazine.*

ORIGIN OF THE GULF STREAM.

Mr. C. W. Denison, as the result of eight years' investigation, has submitted the following propositions to the Polytechnic Association of the American Institute:—

1. The Gulf Stream is of subterranean origin.
2. Its progress, in a certain direction and rate, is caused by the shape and revolutions of the planet.
3. It is heated by interior volcanic fires, supplied from the igneous portions of the globe.
4. The Gulf Stream is fed from beneath by a constant flow of waters. Some of these are the Mediterranean and other adjacent seas.
5. The colour, heat, current, motion, *animalculæ*, sedges, taste, odour, and all the other peculiarities of the Gulf Stream, prove it to be subterranean in its origin and progress.
6. The trade winds and the formation of the shore of the Gulf of Mexico, have nothing to do with the origin, characteristics, and progress of the Gulf Stream.

The colour of the Gulf Stream, he said, is deep blue. That this is not caused by its saltness is evident, first, because salt would not make it blue ; and, second, because it is no more salt than the adjacent waters which are not blue.

The colour is caused by the sulphate of copper which the water contains in solution. The water enters the Mediterranean Sea from the ocean at the rate of three miles an hour, and this is exactly the rate of the Gulf Stream, indicating a connexion between the two. His explanation of the phenomenon is that the water of the Mediterranean sinks into a vast chasm in the earth at Scylla and Charybdis, and thence passes westward through the interior of the earth, becoming heated by volcanic fires, and charged with the sulphate of copper, until it finds vent in a vast chasm along the American shore. The water of the Gulf Stream is in perpetual eddies, as though boiling up from below. The *animalculæ* of the Gulf Stream are not found in the Gulf of Mexico or the Bay of Campeachy, but are identical with those found in the Mediterranean sea. The sedges found in the Gulf Stream are identical with the fuci of Egypt, and are probably derived from the Nile. The odour and taste, derived from the sulphate of copper, are found only in our Gulf Stream, and in similar streams. The reason of the failure of the Atlantic Telegraph was probably, that there is a deep chasm opposite the coast of Ireland, the bottom of which no cable could reach. The geysers of Iceland rise and fall with the tides, indicating a connexion with the ocean, while warmed by volcanic fires.

THE CAUSES OF EARTHQUAKES.

FROM observations made at different times upon a volcanic mountain, called La Souffriere, or the Sulphur Hill, in the island of Guadaloupe, M. Gentili, a physician in the French navy, has concluded that Earthquakes are accompanied by the sinking of mountains. The base of La Souffriere is composed of trachyte. If we suppose its interior and the lower strata surrounding it to be formed of large solid angular blocks of this substance, with numerous intervening spaces filled with gases, then the escape of these gases by the mouth of the volcano, and the filling up of these vacant spaces by the settling down of the trachytic blocks will cause earthquakes. This appears to be the case in Guadaloupe, where earthquakes are very frequent. The island in the vicinity of La Souffriere is almost always in motion, and appears to have sunk considerably during the past half-century. About fifty years ago, its height, according to Moreau de Jonnes, was 1570 mètres. In 1843 it was measured by M. Ch. Sainte-Claire Deville, and found to be 1484 mètres. M. Gentili has lately measured its height twice with great care, and found it to be only 1460 mètres. These measurements prove that this mountain is gradually sinking. From these facts M. Gentili infers in general that the sinking of mountains is the cause of earthquakes. The inference should, however, be accepted with limitation, as there may be several causes of earthquakes. They may arise from chemical as well as from mechanical changes in the interior of the earth. In the present state of our knowledge we can only say that earthquakes and the sinking of mountains accompany each other.—*Mechanics' Magazine.*

COMPARISON OF THE TEMPERATURE IN THE AIR AND OF THE SOIL AT A DEPTH OF TWO METRES.

FROM observations made during five consecutive years on the Temperature of the Soil at a depth of 2 mètres compared with that of the Air, it follows—

1. That the mean temperature in the air was 10°·21, and in the soil 12°·79. Difference in favour of the soil 2·58.
2. That the mean temperature of the soil in winter and autumn is higher than that of the air; that in summer it is about two degrees lower, and that in spring the mean temperatures are virtually equal.
3. That the mean of the extreme maximum temperatures in the air was 34°·5, in the soil it was 19°·75. On the other hand, the mean of the extreme minima in air was — 12°·14; in the soil this mean never sank below + 6°.
4. While in air the mean of the total differences between the extreme maxima and extreme minima reached 46°·64, in the soil this mean was only 13°·74.
5. In 1860 the temperature of the air sank to — 20°, in the soil the minimum was never less than + 5°·47.
6. While in the air the maximum temperature usually occurs in July or August, and the minimum in December or January, the maximum temperature in the soil always corresponds to the end of August; the minimum always occurs at the end of February, or on the first days of March.
7. The changes of temperature in the soil at a depth of 2 mètres may be thus stated:—

While the mean temperature of the air usually begins to sink towards the end of July, in the soil the heat continues to accumulate in the superior layers under the influence of the intense Solar radiation, and to extend to the lower layers, until the end of August. From this point the upper layers begin to lose more heat by radiation than they receive; the flow of heat changes its direction, it passes from the lower to the upper layers and becomes lost in the air; and this ascending motion, continuing until February, is more rapid as the external temperature is lower, that is, as the winter is longer and more severe. Towards the middle of February or the beginning of March the upper layers begin to become heated under the influence of the solar rays, whose direction has become less oblique; the inferior layers give less and less heat to the upper ones; they begin, on the contrary, to receive some, and become then reheated, which continues until the end of August.—*Comptes Rendus*, October 7, 1861.

MINIMUM THERMOMETERS.

MESSRS. NEGRETTI AND ZAMBRA describe their *Minimum* Thermometer to consist of a glass tube, the bulb and part of the bore of which is filled with strong or pure alcohol. During very hot weather, evaporation takes place on the surface of the alcohol, but, the tube being hermetically sealed, the vapour does not escape, but it is (on a decrease of temperature) condensed and invariably deposited at the extreme end of the tube furthest from the bulb; we have known instances of 10, 15, and even 20 degrees of alcohol being thus left at the upper end of the tube. It follows as a matter of course that the readings taken by such an instrument will be too low by the amount *so evaporated* and detached from the indicating column. The

alcohol in the thermometer may be very visible, it may even be highly coloured, but the portion left behind by evaporation, and deposited as described, will be so transparent and colourless that it requires a practised eye to detect it. The following simple rule should be observed in suspending *minimum* thermometers :—The thermometer should be suspended in such a position that the bulb shall be at least one inch lower than the upper end of the instrument. It is generally believed that the thermometer is to be hung perfectly horizontal ; this is wrong. If the thermometer is placed in the position we have described, the vapour, when condensing, will drain back to the main or indicating column ; and the thermometer, if a correct one, will always give correct indications.

M. Casella has also constructed a Minimum Thermometer, the peculiarity of which consists in the attractive or adhesive influence obtained by the junction of the small chamber with the adjoining bent tube or chamber. On the instrument being set for observation, in a horizontal position, with the back plate suspended on a nail, and the lower part supported on a hook, the bulb end may be raised or lowered, until the bent part is full of mercury and the chamber is quite empty ; at this point the mercury in the bore of the tube indicates the exact temperature of the bulb or air at the time. On an increase of temperature, the resistance of capillarity in the bore renders it easier for the mercury to expand into the small chamber than along the narrow bore of the tube ; whilst a return of cold will, for the same reason, cause its recession from this chamber only, until it reaches the flattened surface, to which the mercury adheres, as to a fixed point, and any further diminution of heat withdraws the mercury down the bore to whatever degree the cold may attain, where it remains until further withdrawn by increased cold, or till reset for future observation. By this means, cold may be registered to any fraction of a degree observable on the most delicate standard.

LUSTRE.

SIR DAVID BREWSTER, in studying the subject of Lustre, has observed the following: In a daguerreotype, for example, of two figures in black bronze, with a high metallic lustre, it was impossible by looking at either of the pictures to tell the material of which they were made. No lustre whatever was visible ; but when the two equally shaded pictures were combined in the stereoscope, the lustre and true character of the material was instantly seen. Another instructive example was seen in the stereoscopic representation of a boy blowing a soap-bubble. The lustre of the watery sphere was not visible in either of the two pictures, but when they were combined it was distinctly seen. In both these cases, and in others of the same kind, tints of similar intensity were combined, as in the case of the suspended papered wall, and there was no ground for assuming that the two surfaces combined appeared at different distances, and that the one was seen through the other, as in Professor Dove's theory.

Electrical Science.

THERMO-ELECTRIC CURRENTS IN CIRCUITS OF ONE METAL.

BY FLEEMING JENKIN.*

In the course of some thermo-electrical experiments, I was led to examine the effect of various distributions of heat in Circuits formed by One Metal. I verified the conclusion arrived at by Professor Magnus, that no distribution or movement of heat in a continuous and homogeneous piece of metal will produce a current of electricity.

I also repeated, with some variations, the experiments of Seebeck and Magnus, which show that, if one end of a wire be heated, the other remaining cold, a momentary or transient current of electricity will be developed when contact is suddenly made between the hot and cold ends; the direction of the current depending on the metal employed.

I found that I could obtain permanent currents in the same direction from each metal if I simply looped the two ends of the wire together, and heated one of the two loops; and, moreover, that the current was much greater when there was a loose contact between the two wires that when the two loops were tightly drawn together. It is to these currents, due to loose contact between a hot and cold wire of the same metal, that I wish to direct the attention of the Section. I will first shortly describe the apparatus used, and the experiments which showed the existence and importance of these currents, and I will then endeavour to repeat some of the experiments before you. I used a reflecting galvanometer of the form constructed by Professor W. Thomson, of Glasgow. A very light mirror, attached to a very small magnet, hung inside the galvanometer coil, reflects the light of a lamp upon a scale about two feet off. Very small deflections of the magnet are distinctly shown by the movement of the reflected spot of light, while the slight inertia of the moving parts has great advantages when rapidly varying currents are to be observed. A common spirit-lamp was used to heat the wires, which were from 0·02 in. to 0·05 in. in diameter.

When two pieces of similar copper wire are connected with a galvanometer, and the end of one wire is heated, a momentary current flows from the hot wire across the joint to the cold one whenever they are suddenly brought in contact. While repeating this experiment, due to Seebeck and Magnus, I found that if the two ends of two such copper wires (being equally oxidized and annealed) were looped together and held tightly in contact, little or no current could be observed when one of the loops was heated in the flame; but when the two loops were separated, I observed a momentary current in the same direction as that produced when the hot and cold wire were suddenly joined, *i.e.*, from hot to cold across the joint. This fact excited my attention, and led me to consider what

* Read to the British Association, 1861.

the acts of making and breaking contact could possibly have in common. I reflected that when two wires are approaching or receding, they equally pass through points at every possible distance (within limits) one from the other. Thus I thought that the relative distance between the two wires might be the peculiarity which, being common to the two acts, might produce similar effects in each case. I therefore tried the effect of a loose contact between the two wires, resting the one wire very lightly on the other, instead of pressing or pulling the two together.

A permanent current was at once produced so strong as to hold the deflecting magnet of the galvanometer against its limiting stops. I then introduced resistance coils into the circuit, for the purpose of reducing the deflection, but, to my surprise, it was not until I had added a resistance equal to that of 2000 miles of the Red Sea cable, or about 1000 miles of the common No. 16 copper, that I reduced the deflections within the range of my galvanometer.

The current could be maintained through this resistance for twenty minutes at a time. Not perfectly constant, indeed, but not wavering more than was inevitable from the varying pressure given by the hand to the two wires. The current was strongest when one end of the wire was white hot, the other being dark red.

I varied the experiment in many ways, using different galvanometers and different copper wires, but always with one result. A tight contact gave a barely sensible current; a loose contact gave a current which could be maintained permanently equal to that which would be produced through a similar resistance by the eighth or tenth part of a Daniell's cell—a strength sufficient to signal through a cable to America, if ever one be laid.

I next tried the same experiment with iron wires. Analogous results were obtained, but with one remarkable difference, viz., that the direction of the current was from cold to hot across the joint, instead of from hot to cold, as in copper; moreover, a very sensible current was always observed in iron, even when the two loops were firmly held together; it seems possible that this effect is only a residue of the effect caused by a loose contact, the hard oxide of iron precluding a perfect metallic contact between the loops. The effect is increased at least fivefold when a loose contact is made.

The maximum electro-motive force to be obtained from iron is about one-twentieth that given by copper, and acts in the opposite direction. Platinum gives no current with tight contacts; with loose contacts a weak current flows in the same direction as that given by copper. I must here warn anybody disposed to repeat these experiments that the resistance of the loose contact is itself considerable, and if the whole circuit, including the galvanometer, be of small resistance, the strongest deflection will be obtained with comparatively tight contacts; for, although the electro-motive force is increased by loosening the contact, the total resistance of the current may be increased in a still higher proportion, and the strength of the current will then diminish. This effect is analogous to the well-known fact in voltaic electricity, that, by the addition of

small cells in series to a battery with large surfaces, the strength of the current may be reduced if the total resistance of the circuit be small, but will be increased if the total resistance be large. Thus the effects of loose contacts are best seen on a sensitive galvanometer with a large resistance in circuit.

These phenomena may apparently be due to a thermo-electric absorption of heat at the joint, or to a chemical effect on one of the wires, the air or oxide acting as an electrolyte. The opposite direction of the current in iron and copper, however, gives a reason for believing that chemical action is not the cause of the current. The decided effect obtained with platinum is another argument for this belief. It is, moreover, well established, that any variation in the molecular structure of a metal causes one part to become thermo-electrically positive or negative with respect to the other; thus thermo-electric couples can be made of hard and soft wire of one metal, or of crystals arranged axially and equatorially; the current being supported by the Peltier absorption and evolution of heat. Now, discontinuity is the greatest possible change which can occur in the molecular structure, and it therefore appears not improbable that the currents due to loose contacts, or, in other words, to discontinuity, may be due to the same cause as the currents due to varying temper, or to crystalline structure; that is to say, to absorption of heat where the change of structure occurs, heat being evolved in other parts of the current at a lower temperature. I hope soon to decide this question by further experiments in various media with definite pressures at definite temperatures.

When various metals are combined, striking effects are produced, the common thermo-electric current from the joint being often increased fifty or a hundredfold; when loose contacts are substituted for tight contacts, the direction of the current is also frequently reversed.

The results of these combinations are necessarily complicated, and require further experiment and analysis before publication.

In the ordinary thermo-electric battery, made from pairs of dissimilar metals, a very small proportion of the heat communicated to the joint is converted into electricity, which is, therefore, obtained from them at a great disadvantage. But, considering the comparatively great intensity of the currents produced when loose contacts are adopted, it seems possible that, by their means, a considerable part of the heat used may be absorbed in the production of electricity, which would, in that case, be more cheaply obtained from heat than directly from chemical action.

It is needless to allude to the consequences which would ensue should a cheap source of electricity be discovered; but without anticipating such important consequences from the discovery of the loose contact currents, they certainly seem a fit subject for further investigation, and, meanwhile, it is interesting to consider how, when two wires are tightly joined, the heat given them by the flame travels but a few inches slowly along them, producing all its sensible effects on objects in the immediate neighbourhood, whereas,

when these wires are moved asunder to an almost imperceptible distance, that same heat may in an instant be flashed as electricity through thousands of miles, reappearing distributed once more in the form of heat almost simultaneously in every part of the whole circuit.

THE TORPEDO.—NEW EXPERIMENTS.

THERE have been communicated to the Royal Society "Results of Researches on the Electric Function of the Torpedo," by Professor Carlo Matteucci, of Pisa, in a letter to Dr. Sharpey, Sec. R.S.

It has hitherto been believed that the action of the electric organ of the torpedo was momentary only;—that it becomes charged, under the influence of nervous action and discharged immediately that action ceases, somewhat like soft iron under the influence of an electric current. Such, however, is not the real state of the case. The electric organ is always charged. It may be conclusively shown by experiment that the action of that organ never ceases, and that round the body of a torpedo, and probably of every other electric fish, there is a continual circulation of electricity in the liquid medium in which the animal is immersed. In fact, when the electric organ, or even a fragment of it, is removed from the living fish, and placed between the ends of a galvanometer, the needle remains deflected at a constant angle for twenty or thirty hours, or even longer.

I must here explain that in electro-physiological experiments it is highly advantageous to employ, as extremities of the galvanometer, plates of amalgamated zinc immersed in a neutral saturated solution of sulphate of zinc. This arrangement, which can be worked with the greatest facility, gives a perfectly homogeneous circuit, leaving the needle at zero in an instrument of 24,000 coils; the liquid in contact with the animal part experimented on has the greatest possible conductibility, while it does not act chemically on the tissue, and the apparatus is entirely free from secondary polarity.

To return to the torpedo. The electric organ, or a portion of it, detached from the fish and kept at the temperature of freezing, preserves its electromotive properties for four, six, or even eight days; and an organ which has been kept for twenty-four hours in a vessel surrounded with a frigorific mixture of ice and salt, is found to possess an electro-motive power as great as that of the organ recently detached from the living fish. Thus the electric organ retains its functional activity long after both muscular and nervous excitability have been extinguished.

What, then, is the action of the nerves on this apparatus? Here again experiment affords a very distinct and conclusive answer. Detach the organ of a live torpedo and cut it into two equal portions, in such a way as to leave each half in connexion with one of the large nervous trunks; place the two halves on a plate of gutta-percha, with electric *couples opposed*; that is, with the similar surfaces (say

the dorsal) in contact; and connect the two free (ventral) surfaces with the extremities of the galvanometer. There will usually be no deflection of the needle, or, at most, a very slight effect, which will soon disappear. Now, after having opened the circuit of the galvanometer, irritate the nerve of one of the segments, by pinching, by the interrupted electric current, or in any other way; or prick the piece itself with a needle. The portion of organ thus stimulated will give several discharges in succession, and a rheoscopic frog's limb with its nerve applied to the part will each time be thrown into violent convulsions. If, after this, the galvanometer be applied as before, there will be a very strong deflection in a direction answering to the segment stimulated. This deviation endures for a short time, but gradually becomes less, so that in a few minutes the effect of the two segments is equal. Stimulation now of the other segment will in like manner render its electricity predominant. These alternations may be repeated several times, but naturally the effect becomes less and less marked.

Thus the electromotive apparatus becomes charged and acts independently of the influence of the nerves, but that influence renews and renders persistent the activity of the apparatus. We know, moreover, that the discharge, which is only a state of temporary increased activity of the organ, is brought on by an act of the will in the live animal, or by the excitation of the nerves of the organ.

I shall not enter now into further details respecting my recent experiments on the torpedo, but I venture to think that we have really made a step towards clearing up the theory of the animal electro-motive apparatus. The organ of the torpedo does not, under the influence of the nerves, act as an induction apparatus; the operation seems more analogous to that of a "secondary pile," created, through the influence of the nerves, in each constituent cell of the organ.

The case is very different in muscular action, the changes occurring in which are better understood now that we know the phenomena of muscular respiration. I do not here refer to the variation of the muscular current which takes place at the moment of contraction. In that case it would appear from experiment, as I lately showed, that there are indications of a current in an opposite direction; but the conditions of the animal structure in action are so complex that no inference can be drawn as to the intimate nature of the phenomenon. It is otherwise, however, in comparing muscles which have been left at rest with muscles which have been fatigued by repeated contraction.

PRODUCTION OF THE GREEN MATTER OF LEAVES UNDER THE ELECTRIC LIGHT.

M. HERVÉ MANGON has ascertained, by experiment, whether the *Green Matter* developed so readily in young Leaves exposed to the

sun, is also produced under the influence of the bright light of the electric lamp.

The electricity was produced by a powerful electro-magnetic machine driven by a steam-engine. The light was that of a charcoal lamp. The lamp was lit for eleven hours on July 30, twelve hours on July 31, August 1 and 2, and eleven hours and a half on August 3. The temperature of the air varied from 22° to 25° C., and that of the earth from 19° to 21° C.

On the 30th of July, at eight in the morning, small flower-pots, each containing four grains of rye, sown respectively on the 24th, 26th, 27th, and 28th of July, were placed in a perfectly dark room, about a yard from the lamp, and about 2 feet below the luminous focus, and without the interposition of any glass.

The grains sown on the 24th and 26th had sprouted; the stalks were 0·005 mètre to 0·012 mètre in length. There was a slight green tint on the top of one of these plants; the other was quite white. The grains sown on the 27th and 28th of July had not sprouted on the 31st of July at 2 o'clock; the plants sown on the 24th and 26th of July were 0·010 mètre to 0·060 mètre in length; they were all *very green*, and strongly turned towards the light. The grains sown on the 27th of July had sprouted; the plants were 0·020 mètre to 0·030 mètre high, and there was a little green on the top of one of them.

At 1 o'clock on the 1st of August the plants continued to grow just as in the light. The rye sown on the 28th of July had sprouted, but showed no green.

On the 2nd of August, at 2 o'clock, all the plants continued to grow; the rye which had sprouted on the night before was decidedly green.

The seeds kept in the dark for the sake of comparison, gave plants which were completely yellow.—*Comptes Rendus; Philosophical Magazine.*

THE LEYDEN JAR.

PROFESSOR TYNDALL, in his Fifth Lecture on Electricity, at the Royal Institution, continued his experimental illustrations of the Leyden Jar. Its inventors discovering that the intensity of the charge increased with the magnitude of the jar, were led thus to find that a number of jars connected together by conductors may be charged with very nearly the same amount of electricity as when separate. Jars thus arranged form the Leyden battery. If the charge be too intense, the positive electricity flashes across the glass of each jar to the negative on the exterior, fracturing the glass. An electrometer is used to show when the battery is charged. By means of a battery of fifteen jars charged by a large electric-machine, the Professor showed the electric discharge in a beautiful spiral form in a glass tube, containing patches of tinfoil; he burnt a piece of silver wire, &c. He also exhibited the phenomena termed Lichtenberg's figures. Two Leyden jars were charged with electricity—one posi-

tive, the other negative. Sparks were given from their conductors to a disc of resin, which was then sprinkled with lycopodium powder. When the loose powder was blown off, that portion which remained exhibited irregular branchlike and radiating forms. He also demonstrated by experiment that the discharge of the jar takes place at the same moment at the inner and outer coatings, the middle of the connecting medium being the latest electrified. He also showed how the primary current of a Leyden battery can excite a secondary current in an adjacent wire, which can excite a tertiary, by which also a fourth current may be excited. A silver wire was burnt by a secondary current. The velocity of the electric current has been estimated by Wheatstone at 288,000 miles per second. A spark from the Leyden battery through copper wire passed through gunpowder without igniting it: it had not time. When, however, a damp string was substituted for the wire, the passage of the current was retarded and the powder was fired. The action of electricity on the magnetic-needle (often giving trouble at sea) was also exhibited. The mechanical effects of the electric discharge were referred to, and its destructive consequences illustrated in the parts of a tree which had been rent asunder by lightning. With regard to the physiological effects of the electric current, it was stated that a shock from a battery had been given to six hundred persons at once, and that Franklin had by a shock knocked down one hundred men, each of whom had placed his hand on his neighbour's head. The joints are specially affected.—*Illustrated London News*.

ELECTRO-MOTIVE MACHINES.

In the "Scientific News" of the journal quoted in the previous article, it is observed that Electro-Motive Machines depend on the power which soft iron possesses of acquiring, under the influence of the electric current, an enormous magnetic power, and of losing it instantly that the current ceases to circulate, whereby a rotatory motion of immense rapidity is easily produced. Unfortunately, this attraction diminishes rapidly with the distance. To overcome this inconvenience, a distinguished engineer, M. Froment, has devoted much time, and believes that, within certain limits, these machines may be made useful. We cannot give details; but we learn from a memoir by M. De la Rive in the *Bibliothèque Universelle* that a machine constructed of eighty electro-magnets in six frames and ten movable wheels making the contacts has given a power of fifty-five kilogrammètres per second. M. De la Rive, however, does not think that electro-motive machines can ever be profitably employed in industrial pursuits, but points out their advantage in regard to their avoiding the dangers of fire and explosion, as in the case of steam, and in requiring only a voltaic battery to put them in action.

ELECTRICITY OF FRICTION AND CONTACT.

In a memoir translated in the *Bibliothèque de Genève* M. H. Buff considers the analogy of the sources of the Electricity of Friction and Contact, and gives, as the result of numerous experiments, his opinion that the contact of heterogeneous substances is the cause of the former. This conclusion is combated by the editor, M. A. De la Rive, who does not consider it to be fairly derived from the facts related. He considers that the experiments on the generation of electricity by pressure, from which M. Buff derives one of his principal arguments in favour of the contact theory, seem rather to prove that the origin of the electricity is much more related to the molecular movements, which arise as much from pressure as from rubbing; since, according to the nature of these movements, it is sometimes the positive, sometimes the negative, fluid with which the two rubbed or pressed substances are charged.—*Illustrated London News.*

A NEW ELECTRIC MACHINE

Has been exhibited at the Royal Institution by Mr. C. Varley. Its peculiarities consist in having an ebonite plate and one of Professor Winter's new conductors in the form of a wooden ring. The exciting power of ebonite (hardened vulcanized India-rubber) being greater than that of glass in the proportion to 15 to 12, a spark varying from 16 to 19 inches is given. When an amalgam rubber is employed, positive electricity is obtained; when a moleskin or catskin rubber is used the electricity is negative.

EXPERIMENTS WITH THE INDUCTION COIL.

At the London Mechanics' Institution, Mr. E. Wheeler, C.E., has lectured on the Induction Coil, the apparatus used by him being of his own design and construction. In the course of his experiments he showed that, in common coal gas of moderate density, the spark passed in zig-zag lines of emerald green. Through pure hydrogen it resembled forked lightning of the deepest crimson. Atmospheric air reduced to a vacuum showed a broad ribbon of genuine mauve, a yard long. A similar line of light made to pass over a wine decanter of Uranium glass, in an exhausted receiver, exhibited upon the decanter tints of extreme richness. A hock wine-glass *in vacuo* was made the recipient of a current from the coil; and the electricity streaming over the edges of the wine-glass with roseate tints, seemed like a material liquid flowing from some invisible source, and changing into a brilliant electric cascade. A line of sky-blue light, being caused to traverse an electro-magnet, was seen to revolve round its poles; an illustration of the close relations between light, electricity, and magnetism. An example of the *stratified* form which the light occasionally assumes was supplied in a large glass tube of rarefied carbonic acid gas. In hermetically sealed glass tubes of fantastic shapes, nitrogen gas exhibited pink and carmine tints; sulphurous acid gas, an azure blue; hydrogen, a deep crimson; carbonic oxide,

green. Phosphoric acid gas was visible in the tube by a faint green light for some seconds after the discharge had ceased. A chromatic star, in rapid rotation, and with striking contrasts and endless combinations of colour and light, formed the concluding experiment.

ELECTRIC HEAT.

MR. J. P. GASSIOT, F.R.S., so eminent for his series of brilliant experiments relating to luminous electric discharges *in vacuo*, has sent to the Royal Society a note on the heat developed at the poles of the voltaic battery during the passage of these discharges. We cannot afford the space for details of the experiments, given in the *Royal Society's Proceedings*, which will be sought for by all earnest electricians. Mr. Gassiot concludes by stating that, from the results he obtained, he infers that the development of heat, either at the positive or the negative pole of the battery, is entirely due to the amount of resistance which takes place in that part of the battery circuit. "It is," he says, "beautiful and interesting to observe the suddenness with which the red heat of the negative terminal ball disappears, and the equal suddenness with which the heat at the same instant is elicited at the positive, when the brilliant discharge takes place."—*Illustrated London News.*

THE ELECTRIC LIGHT.

THE experiments with the Electric Light, which have now been made for a long time past at the Palais-Royal, Paris, have been continued with increasing success. Instead of two burners, fed by divided currents from the magneto-electric machine, one burner, fed by a single current, has been used. It is raised sixteen mètres, and illuminates, as with the light of the full moon, the whole square in front of the Palais-Royal, and the two entrances of Rue Saint Honoré. Two hyperbolic reflectors,—one above the light, the other below—increase and diffuse the light. By certain improvements in the prisms or cylinders of artificial carbon, which are used in the production of the light, M. Curmer is now able to make electric lamps, which will burn five or six hours without requiring any attention. The lamp of M. Serrin, placed before the house of Prince Eugene, also burns brilliantly. M. Serrin has succeeded lately in causing his lamp to burn under water almost as well as in the atmosphere. Thus we may now light the bottoms of rivers, or of the sea, or the bottoms of floating vessels, sunken wrecks, the foundations of piers, and other submarine structures. It is expected that we shall soon be able to apply this method of illumination in our lighthouses, ships, and generally on land in our cities and houses. At the Invalides lately, in the presence of Despretz, Babinet, Foucault, and others, a magneto-electric machine was worked by one of Lenoir's lately-invented gas-engines, of 3-horse power. By this means a strong electric current was generated, and M. Serrin's lamp gave a *very brilliant light*, equal to two hundred Carcel burners.

A perfectly successful attempt has been made to illuminate the Courts of the Tuileries, and the Place du Carrousel by the electric light. The generating apparatus is placed in a cellar under Marshal Vaillant's apartments in the Tuileries, and the illuminating power is so great that the ordinary gas jets seem absolutely lightless. The appearance of these localities every evening is that of an animated fair. The cost of the electric light is stated to be considerably less than that of gas. (This is a most important result; since the *cost* of the Electric Light has been the main obstacle to its general use.)

FIRING GUNPOWDER BY ELECTRICITY.

An important Report has been presented to the Secretary of State for War on the results of elaborate investigations and experiments made at Woolwich and Chatham by a Committee on the Application of Electricity from different sources to the Explosion of Gunpowder. The Report is drawn up by Professor Wheatstone and Mr. Abel, Chemist to the War Department. The following are the conclusions arrived at:—

1st. The explosion of a single charge of powder by means of the phosphide of copper fuze and a magneto-electric apparatus (even of the smallest size generally manufactured) is absolutely certain.

2nd. The phosphide of copper fuze is as safe and permanent as any arrangement employed in the service for the ignition of gunpowder by the aid of friction or percussion.

3rd. With the employment of a magneto-electric apparatus similar to that used in the Chatham experiments, and termed by Mr. Wheatstone, the "Magnetic Exploder," the ignition at one time of fuzes, varying in number from 2 to 25, is certain, provided these fuzes are arranged in the branches of a divided circuit in the manner described. To attain this result it is only necessary to employ a single wire, insulated by a coating of gutta-percha or India-rubber, and simple metallic connexions of the apparatus and the charge with the earth.

4th. The explosion of from 12 to 25 charges may be effected in the above manner, at a distance of at least 600 yards from the apparatus, with a rapidity which in its results will in all probability have the practical effect of a simultaneous discharge. This statement, however, only refers to charges on land.

5th. The number of submarine charges which can be exploded with certainty at one time by means of the magnetic exploder is more limited; but if such charges are entirely or partially imbedded in sand, mud, or other dense materials, from two to ten may be fired with certainty. If the charges are suspended in, or are immediately in contact with water, only four can be exploded at one time with certainty. By the employment of separate wires leading from the instrument to each charge, there is little doubt, however, that the results obtained with the magnetic exploder in submarine operations would be quite equal to those definitely established for the ignition of charges on land.

6th. The only important precautions to which it is necessary to attend rigidly n order to ensure uniform success in the application of the magnet are the proper insulation, throughout, of the main wire and branch wires leading from the instrument to the charges, and the thorough protection of all connexions of wires from the access of moisture.

7th. The system of firing charges by magneto-electricity thus possesses important advantages over the application of the voltaic battery to this purpose: the principal of which are,—the small dimensions, weight, and cost of the magnetic exploder; that used in the experiments alluded to in the report weighed only 32 lb. 11 oz., and all the arrangements in connexion with the instrument are so simple, that any injury which they may sustain can be repaired by ordinary workmen.

Electricity was applied to the explosion of gunpowder by Franklin in 1751, and by Priestley in 1767; but it was not till after the discovery of the voltaic pile that earnest endeavours were made to apply electricity to mining and military purposes. In 1832 French military engineers experimented on it. About twelve years afterwards, electricity was employed in important blasting operations—such as the destruction of Round Down Cliff, near Dover, and of the wreck of the *Royal George* at Spithead. The valuable discoveries of Faraday in electro-magnetism and magneto-electricity of late years have gradually led to the experiments on the possible application of electro-magnetic induction apparatus for military purposes.

ATMOSPHERIC ELECTRICITY.

THERE has been read to the Literary and Philosophical Society of Manchester a paper "On the Prevalence of certain forms of Disease in connexion with Hail and Snow Showers, and the Electric condition of the Atmosphere," by Dr. Thomas Moffat, F.G.S. In 1852, while deducing results from the meteorological observations of the two previous years, the author observed that an intimate connexion existed between falls of snow and hail and diseases of the nervous centres, such as apoplexy, epilepsy, paralysis, and vertigo; and the results of eight more years bear out the truth of the observation. A table formed from 236 cases of the above diseases, and upwards of 1000 observations of the electrometer, is given, showing the percentage of hail and snow showers, the cases of diseases of the nervous centres, and the times that the air was positive and negative with each wind. From this table it appears that with the wind from the N., N.E., E., and S.E. points, which the author calls the *snow* points, the per-centage of hail and snow showers is 23·2; of cases of apoplexy, &c., 36·7; of positive electricity, 27·0; and of negative electricity, 34·1; while with the wind from the *hail* points, S., S.W., W., and N.W., the per-centages are respectively 76·6, 65·7, 72·6, and 67·5, thus showing that the number of cases of disease increases with the frequency of hail and snow showers, and the consequently increased frequency of the alternations of positive and negative electricity. All observers agree that the air is negative on the approach of great storms, and negative, or alternately negative and positive, in unsettled weather; and the author remarks, that such storms are almost invariably accompanied by convulsive diseases, or diseases of the nervous centres in some form; and in support of his statement he quotes many cases from his notes of the storms of the last twelve months, but more particularly the succession of gales which occurred from the 21st to the 30th of October, 1859 (in one of which the *Royal Charter* was lost), the gales of the 25th, 26th, and 27th of May last, which were accompanied with frequent hail-showers; and those of the 24th of August and four following days. Other forms of disease accompany these atmospheric conditions, such as premature uterine action, epistaxis, and diarrhœa, with vomiting and

cramps; and it would thus appear that negative electricity plays an important part in the above atmospheric conditions and morbid actions.—*Edinburgh New Philosophical Journal.*

SIR W. ARMSTRONG'S HYDRO-ELECTRIC MACHINE.

THIS machine has been fairly tried at Woolwich Arsenal. Mr. Abel considers that it would be an efficient agent in great mining operations, but would require considerable modifications to adapt it to military purposes, for which preference should be given to Mr. Wheatstone's "magnetic exploder," the power of which is due to magneto-electricity (discovered by Faraday). Among its advantages are reckoned certainty of action, the safety and permanence of the copper fuze employed, unlimited number of charges, rapidity of discharge, and adaptability to submarine operations.

DIFFICULTIES OF OCEAN TELEGRAPHY.

THE President, in his opening address to the British Association, observed:—"In land telegraphy the chief difficulties have been surmounted; but in submarine telegraphy much remains to be accomplished. Failures have been repeated so often as to call for a commission on the part of the Government to inquire into the causes, and the best means of overcoming the difficulties which present themselves. I had the honour to serve on that commission; and I believe that from the report, and mass of evidence and experimental research accumulated, the public will derive very important information. Three conditions are essential to success in the construction of Ocean Telegraphs,—perfect insulation, external protection, and appropriate apparatus for laying the cable safely on its ocean bed. That we are far from having succeeded in fulfilling these conditions is evident from the fact that out of 12,000 miles of submarine cable which have been laid since 1851, only 3000 miles are actually in working order, so that three-fourths may be considered as a failure and loss to the country. The insulators hitherto employed are subject to deterioration from mechanical violence, chemical decomposition or decay, and from the absorption of water; the last circumstance does not appear to influence seriously the durability of cables. Electrically, India-rubber possesses high advantages, and next to it, Wray's compound and pure gutta-percha far surpass the commercial gutta-percha hitherto employed; but it remains to be seen whether the mechanical and commercial difficulties in the employment of these new materials can be successfully overcome. The external protecting covering is still a subject of anxious consideration. The objections to iron wire are its weight and liability to corrosion. Hemp has been substituted, but at present with no satisfactory result. All these difficulties, together with those connected with the coiling and paying out of the cable, will no doubt yield to careful experiment

practice a considerable rapidity can be acquired in sending messages. Without such an instrument as this, a trained establishment of clerks would be necessary to work the telegraph. By its aid the owner of the telegraph, or any person of ordinary education, can use it with scarcely any training. Some idea of the speed with which this automatic printing telegraph can forward messages may be estimated when we state that a column of newspaper print, such as that of a parliamentary debate, can be transmitted 200 miles in about twenty minutes.

Town Telegraphs.—Copper wire no thicker than the cotton on a lady's work-table can be coated with India-rubber not thicker than paper, and through this delicate material electricity may be made to travel for at least twenty miles, and to transmit intelligible signals. A rope can be made of thirty of these thin strands, coiled and twisted into a cable of the size of one's middle finger, but little heavier than a piece of hempen rope of the same dimensions, and a highway may thus be formed for thirty different conductors of intelligence. This cable or "electric highway" may be suspended over the house-tops; for, unlike gutta-percha, the India-rubber insulation will not be affected by the smoke from the chimneys, nor by the heat of the summer sun. It is proposed to connect every part of London, and some other large towns, by a system of triangulation. The whole metropolis will be divided into a system of triangles, the sides of each being about a mile in length; each point of the triangles being united to the adjoining ones by one of these cables of insulated wires. The wires of these electric cables will be available for private use; and, just as in the case of the gas or water companies, any person in the district may have a wire laid on for his private and special convenience, paying a rental to the company for its use. The charge made by the London District Telegraph Company for single messages is 4d., and 6d. for message and answer to and from any part of the metropolis [when and where their wires are strung, we presume], including the cost of delivering and receiving the messages.

Portable War Telegraph.—At Chalons, the following has been constructed: A carriage is constructed, in which several cylinders or enormous bobbins are fixed, round which is rolled a quantity of iron wire of the thickness of a strong cord. This wire is passed by machinery into the box of one of the wheels, and according as the carriage moves the wheel turns and unrols the wire. A platoon of cavalry soldiers follows. Two men alight at every fifty paces to raise the wire on a slight stick. Four others do the same, while the first are moving forward, and raise the wire with a forked pole, which they fix in the ground, and which is fastened with cords strengthened with iron plates. That being done, they relieve the other workmen, and they do so in turn. The horses in the carriage go forward at a gallop, and the telegraph is fixed with extraordinary rapidity. The apparatus is worked in the carriage, which serves as an office. During the last manœuvres, Marshal M'Mahon tried this invention over a space of from seven to eight kilomètres, and it suc-

ceeded perfectly. Moreover, when it is intended to return, the action of the cylinders is reversed, and the carriage is turned round, preceded by the men, who take down the poles, replace them in a light waggon, and wind up the bobbins.

The Paris Correspondent of the *Times* states that a successful trial has been made between Paris and Amiens of a new telegraphic apparatus, which transmits messages textually, and which reproduces line for line the handwriting of the person forwarding the despatch.

Malta and Alexandria Telegraph.—The Malta and Alexandria cable has been successfully laid. This is the second instance in which Her Majesty's Government have ventured to expend public money upon undertakings of the kind. The first case was the temporary line laid for war purposes from Varna to the Crimea, and although its existence was short it did good service, and tended in a great measure to shorten the duration of the war, and thereby saved the country much treasure and many valuable lives.

This cable was originally designed and intended to be laid from Falmouth to Gibraltar. It was subsequently determined to lay the cable from Rangoon to Singapore, and the whole length was made with that end in view, and some of it was actually shipped for that destination. It was supplied by the Gutta-Percha Company.

The first portion of this cable left England on board the steamship *Malacca* last May, and on the 28th of that month the laying of it was commenced at Malta. The direct distance from Malta to Alexandria is about·850 nautical miles; but as it was considered desirable to lay this as a coast line, it was taken direct from Malta to Tripoli, and thence round the coast to Benghazi and Alexandria, a distance of about 1300 miles. It was also very desirable to divide this long length of cable into three sections, and therefore Tripoli and Benghazi were chosen as the most suitable localities for stations; in fact, they are almost the only places along the coast where they could be established. The first portion of the line laid was the section from Malta to Tripoli, at which place the cable was landed about 8 p.m. of May 29th, paying out about 230 miles of cable in 43 hours, equal to a rate of 5¾ miles per hour. Two days were spent at Tripoli, making the land connexions and giving time to the engineers and electricians to satisfy themselves that the cable was good and in thorough working order. The *Malacca* brought from England 518 miles or knots of cable; 230 were expended, leaving 288 yet to be laid; but to reach the next station, Benghazi, required upwards of 500 miles of cable. It was therefore only possible in this trip to lay a portion of the section. About 1 o'clock a.m., after the pre-arranged signal was made from the *Malacca*, the lights of the *Medina* and *Scourge* were seen steadily to draw a-head and take up their respective positions, by which time the *Malacca's* anchor was up and a second fair start made. On both occasions it happened that operations were commenced at night, but so perfect was the machinery, and so well trained were the hands employed in the execution of the work, that not the slightest inconvenience occurred.

Before 8 o'clock on June 3rd, the end of this portion of the cable was attached to a buoy, the cable and buoy were dropped, and bearings and observations taken. The time occupied in laying this portion was 55 hours, giving a similar average per hour as that between Malta and Tripoli. Thus, during 98 hours occupied in paying out, 518 miles of cable were successfully laid at the bottom of the sea. About the 1st of July the *Rangoon*, a sister ship of the *Malacca*, and built purposely for this cable, arrived at Alexandria with Mr. Forde, the Government engineer, and his staff, and Mr. Canning, the engineer of the contractors, with his assistants. The *Medina*, *Scourge*, and *Mohawk* had previously arrived. The weather was then a little unsettled, and it was not until the 5th of July that the sea was sufficiently smooth to admit of the landing of the shore end. This was accomplished in the New Port, and about eight in the evening the end was introduced into the cable-house by Mr. Colquhoun, Her Majesty's Cônsul-General in Egypt. On the 11th of July the *Rangoon* performed her duty by discharging the last of her cargo, the end of which was carefully sealed and dropped in a well-known position. The *Rangoon* and *Malacca* subsequently made second trips, carrying the remaining portion of the cable. On the 15th of September the former left Malta, and proceeded to the buoyed end of the Alexandria cable, and completed that section to Benghazi on the 23rd. The *Malacca* joined the expedition at Benghazi, and proceeded on the 25th to the buoyed end of the Tripoli cable, and this section was completed to Benghazi on the afternoon of the 28th of September, the end being landed the same evening under a royal salute of 21 guns, to do honour to the completing of a great undertaking. It is an interesting fact to know that this line, owing to its peculiar construction and more than usual perfect workmanship, tests far better than any other previously laid cable, and the amount of battery power used in the transmission of messages has been reduced to a *minimum;* for instance, the Malta and Tripoli section, 230 miles long, is worked practically with only three cells, and that at the rate of 25 or 30 words a minute; in fact, as fast as a clerk can send signals. No line previously laid had ever before had the course so well sounded and surveyed. This is a most important item in securing success, especially if repairs should ever become necessary, and there is no doubt it has been laid with less strain and has received fairer play in every way than any other. The tests from the commencement of the line to the finish were of the most delicate and searching kind that science and previous experience pointed out; and, above all things, this cable was not only constantly kept submerged during the process of manufacture, but was actually carried out under water, so that if faults did occur they were sure to be detected before passing into the sea. Once the ships were started, they were never stopped on account of defects in the cable.

DIRECT OVERLAND TELEGRAPH FROM CONSTANTINOPLE TO KURRACHEE.

Major-General Sir H. C. Rawlinson has read to the British Association the following paper:—In 1858 the Turkish Government undertook to execute, at its own expense, a line of telegraph from Constantinople to Bussorah, which would form an integral portion of the great line connecting India with Europe. It was foreseen that the line would benefit the Turkish empire; but the money return for the outlay was to be sought in the tariff established for British messages transmitted along the line towards India. The British Government engaged, as soon as there was a fair prospect of the completion of the Turkish undertaking, to carry on the communication from Bussorah to India at its own expense. The line is now in a working and efficient state the whole way from Constantinople to Bagdad. The Porte has declined to accede to a proposition that Her Majesty's Government should incur half the expenses of the improvements, but has formally engaged to carry out all Colonel Kemball's recommendations for giving greater efficiency to the line at his own expense. A submarine cable from Pera across the Bosphorus having been frequently damaged by the anchors of vessels, it was proposed to suspend a wire from the European to the Asiatic side at the narrowest part of the strait—a distance of not more than 1000 yards. The telegraph consists of two distinct wires, one of which is reserved for the exclusive use of the British Government; and a convention is about to be signed with the Turkish Government for the regulation of the respective shares of the expense to be incurred in keeping the line in working order, for fixing the tariff for the transmission of messages, &c. Attention is being more immediately directed to a continuation of the land-line from Bagdad, through Persia, towards India, in the first instance, directly from Bagdad to Teheran, thence to Khanikeen and Kermanshah. From the latter place it will continue to follow the great high road from Babylon eastward. At Teheran the line will join another system of telegraphs, which has been organized in Persia itself. From Bagdad it was proposed to continue the line to Bunder Abbas. The Commissioner in Scinde, the agent for the Government of India, and the Imaum of Muscat, have reported as favourably as could be wished. They were working in what is believed, in the present state of oceanic telegraphy, to be the only practicable direction.

Mr. J. Craufurd remarked, that if Manchester and Calcutta and Bombay are to be brought into communication in ten or fifteen minutes, as they ought to be, it must be by land and not by sea. Our oceanic cables have been total failures. We have sunk two or three millions of money, which might as well have been thrown in the form of sovereigns into the Red Sea. Pharaoh lost his chariots and horsemen; but this country has lost a sum amounting to 50,000*l.* per annum for the next fifty years,—a monstrous sum to spend, and to spend for nothing.

Chemical Science.

DISCOVERIES IN CHEMICAL SCIENCE.

At the late meeting of the British Association at Manchester, the President (Mr. Fairbairn), in his inaugural address, most appropriately observed:—

We ought not in this town to forget that the very rapid advance which has been made in our time by chemistry is due to the law of equivalents, or atomic theory, first discovered by our townsman, John Dalton. A knowledge of the constituents of food has led to important deductions as to the relative nutritive value and commercial importance of different materials. Water has been studied in reference to the deleterious impurities with which it is so apt to be contaminated in its distribution to the inhabitants of large towns. The power of analysis, which enables us to detect adulterations, has been invaluable to the public health. We have another proof of the utility of this science in its application to medicine; and the estimation in which it is held by the medical profession is the true index of its value in the diagnosis and treatment of disease. The largest developments of chemistry, however, have been in connexion with the useful arts. What would now be the condition of calico-printing, bleaching, dyeing, and even agriculture itself, if they had been deprived of the aid of theoretic chemistry? For example: Aniline—first discovered in coal tar by Dr. Hoffmann, who has so admirably developed its properties—is now most extensively used as the basis of red, blue, violet, and green dyes. This important discovery will probably in a few years render this country independent of the world for dyestuffs; and it is more than probable that England, instead of drawing her dyestuffs from foreign countries, may herself become the centre from which all the world will be supplied. Another remarkable advance has recently been made by Bunsen and Kirchhoff in the application of the coloured rays of the prism to analytical research. We may consider their discoveries as the commencement of a new era in analytical chemistry, from the extraordinary facilities they afford in the qualitative detection of the minutest traces of elementary bodies. I must not pass over in silence the valuable light which chemistry has thrown upon the composition of iron and steel. Although Despretz demonstrated many years ago that iron would combine with nitrogen, yet it was not until 1857 that Mr. C. Binks proved that nitrogen is an essential element of steel, and more recently M. Caron and M. Frémy have further elucidated this subject; the former showing that cyanogen is the essential element which converts wrought-iron into steel, the latter combining iron with nitrogen through the medium of *ammonia*, and then converting it into steel by bringing it at the

proper temperature into contact with common coal gas. There is little doubt that in a few years these discoveries will enable Sheffield manufacturers to replace their present uncertain, cumbrous, and expensive process by a method at once simple and inexpensive, and so completely under control as to admit of any required degree of conversion being obtained with absolute certainty.

CHLORINE.

A NEW mode of producing Chlorine is due to the researches of M. Laurens. It consists in decomposing chloride of copper by the action of heat. The operation is conducted in the following manner. Chloride of copper is prepared in the usual manner, either by dissolving oxide of copper or native carbonate of copper in hydrochloric acid, or by the double decomposition of sulphate of copper and chloride of barium. The solution of chloride of copper obtained is evaporated and submitted to crystallization, then the crystalline mass is mixed with sand and perfectly dried (probably in a reverberatory furnace). The dried mixture is introduced into retorts similar to those employed in the fabrication of gas; if these retorts are of iron, they are lined with a coating formed of a mixture of clay and carbon, to isolate the metals. The chloride, heated strongly, is decomposed into *chlorine* and protochloride. The residue of the preparation of chlorine, *i.e.*, the protochloride, is not lost. It can be again converted into chloride by the oxidizing action of the atmosphere in presence of hydrochloric acid. Having thus obtained the regenerated chloride, the operation is repeated as before described, and the circuit may be renewed indefinitely.

HEVEONE.

A SUBSTANCE having this name has been discovered by M. Mathieu, which promises to become of important use in many of the arts. It is a viscous vegetable fat obtained by the action of a high temperature upon a pure kind of caoutchouc. It possesses great powers of adhesion to any surface to which it may be applied, and, as it does not oxidize nor alter in the air, it serves admirably to preserve iron or steel instruments and polished articles from rust or tarnish. It retains this property, even when the coating is so thin as to be almost imperceptible, and consequently it may be constantly kept applied to surgical and philosophical instruments, arms for warfare, hunting, &c., which will thus be always bright. Heveone applied to stopcocks, pistons, screw connexions, &c., renders them at once beautifully mobile and perfectly tight; it never dries or becomes sticky, nor does it attack brass or other metal work as the generality of greases do. Being quite impervious to water, heveone applied to articles made of leather, such as boots, harness, &c., after a few applications, renders them waterproof and supple; it also tends to preserve objects against decay. Lastly, heveone is the best material to use for rifles, whether as a constituent of the

greased wad, or to protect the interior of the barrel from rust. It prevents fouling to a far greater extent than any other kind of grease, and renders the subsequent cleaning a matter of no difficulty. Of its great value for gas and water-taps, we can speak from some considerable experience.—*London Review.*

OZONE.

SCHÖNBEIN has been industriously following up his researches respecting the presence of this peculiar and most important agency in the atmosphere. He has just found that when a strip of paper, moistened with a solution of pyrogallic acid, is introduced into an atmosphere containing Ozone, it is rapidly darkened; whilst, if no ozone be present, the paper retains its original whiteness. A test of this body ought to be as common in a house as a barometer. The test recommended by Dr. Angus Smith, Miss Nightingale, and others, as we have before remarked, is the alkaline permanganates, or Condy's fluid, which, besides, is itself a vehicle of ozone; and, as a free contributor of it, is in extensive use as a sanitary agency identical in its nature with the very ozone of the atmosphere itself—the great scavenger and cleanser of nature. Ozone is almost equivalent to health. In crowded cities or unhealthy neighbourhoods it is scarcely ever to be detected; whilst, on the ocean, the sea shore, or elevated open tracts of country, it is almost invariably present in quantity. The first outbreak of an epidemic, such as cholera, is always heralded by a rapid decrease of ozone in the atmosphere; whilst its re-appearance is almost as certain a sign of the cessation of the sickness. Ozone appears to be essentially electrified oxygen; and that, in truth, is the vital air which we breathe, and which sustains life and health. Were the oxygen of the air *entirely* neutral, or unelectrified, it is doubtful whether it could sustain life or constitute *vital* air at all.

Mr. T. Sterry Hunt, in a paper in *Silliman's Journal,* details certain experiments with ozone, nitrous acid, and nitrogen, and concludes: From this view it follows that the odour and most of the reactions ascribed to ozone are due to nitrous acid which is liberated by the decomposition of atmospheric nitrogen in presence of water and nascent oxygen. We have thus a key to a new theory of nitrification, and an explanation of the experiments of Cloez on the slow formation of nitrite by the action of air exempt from ammonia upon porous bodies moistened with alkaline solutions.

USES OF OZONE.

M. GORUP-BESANEZ* recommends the use of Ozone for cleaning and restoring the colour of old spotted and soiled books and prints. Ozone completely removes writing ink; but printing ink is not attacked by it, at any rate to no perceptible extent: grease spots and mineral colours also remain unchanged, but vegetable colours are

* Liebig's *Annalen*, May, 1861.

completely removed. The method used is as follows:—The air in a sulphuric acid carboy is ozonized by Schönbein's method, which consists in placing in it a piece of phosphorus 3 inches long and ½ an inch thick, and pouring into the carboy as much water at 30° C. as will half cover the phosphorus; the carboy is loosely corked and allowed to stand in a moderately warm place until the air is charged with ozone, which generally requires from twelve to eighteen hours. Without removing the phosphorus and water, the article to be bleached is uniformly moistened with distilled water, and after being rolled up is suspended by a platinum wire in about the centre of the carboy. The roll of paper is soon seen to be continually surrounded by the column of vapour rising from the surface of the phosphorus. The time required for the bleaching depends on the nature of the substance, but never requires more than three days; paper brown with age and coloured with coffee spots, in two days was quite white and clean. If the paper were now dried, it would not only be very brittle, but would also rapidly become brown; hence the acid must be completely removed. The paper is immersed in water, which is frequently renewed, until it only gives a very feeble acid reaction with litmus. It is next placed in water to which a few drops of solution of soda have been added, and then, being spread on a piece of glass and placed in an inclined position, is exposed to a thin stream of water for twenty-four hours. After being allowed to stand till nearly dry, it is carefully removed and dried between blotting-paper.

M. Gorup-Besanez found that ozone was not well adapted for cleaning oil-colours.—*Philosophical Magazine.*

PREPARATION OF OXYGEN.

Engaged in investigating the methods of working up the platinum residues for the Russian Government, Deville and Debray had occasion to examine the different methods of Preparing Oxygen on a large scale. They find* that sulphate of zinc, which, as a waste product, is now so plentiful, furnishes an economical source of this gas. When calcined in an earthen vessel, it is converted into light white oxide, which, when the sulphate is pure, may be used for painting. The temperature required for its decomposition does not exceed that necessary for binoxide of manganese. The other products of the decomposition are sulphurous acid and oxygen, which may be separated by means of the solubility of the former in alkalies; or the following method may be used, which is employed by the authors for preparing oxygen by the decomposition of sulphuric acid.

This body at a red heat may be decomposed into sulphurous acid, water, and oxygen, by means of a very simple apparatus, consisting of a retort, of about five litres, filled with thin platinum foil, or, better, a serpentine tube filled with platinum sponge and heated to

* *Comptes Rendus*, November 26, 1860.

redness. A thin stream of sulphuric acid passes into this apparatus through an S tube; the products pass first through a cooler which condenses the water, and then through a washer of a special form. In this way pure and inodorous gas is obtained, and a solution of sulphurous acid, which may be changed either into sulphite or hyposulphite of soda, or may be used in the sulphuric acid chambers. The expense of oxygen prepared by this plan is very small; for the method consists essentially in abstracting oxygen from the atmosphere. Even if the sulphurous acid were not utilized, sulphuric acid would still be the cheapest source of oxygen, cheaper even than binoxide of manganese.

De Luca describes the following method of preparing oxygen which he has used for some time; it only differs in manipulatory details from that of Deville and Debray. A tubulated retort is filled three-quarters full with pumice and concentrated sulphuric acid, and luted on to a porcelain tube by means of a mixture of asbestos and clay. The tube also contains pumice; it is heated to redness, and the vapour of sulphuric acid passed over it. The oxygen is disengaged with regularity, and is easily purified; in one operation two ounces of acid furnished about a gallon and a quarter of gas. The process is analogous to that in which hydrogen is prepared by decomposing water by iron; and it is not more difficult.—*Philosophical Magazine.*

GREAT PRESSURE ON GASES.

Dr. Andrews has read to the British Association a paper in which he gave an account of some results already obtained in a research with which he is still occupied, on the changes of physical state which occur when the non-condensable Gases are exposed to the combined action of Great Pressures and Low Temperatures.—The gases when compressed were always obtained in the capillary end of thick glass tubes, so that any change they might undergo could be observed. In his earlier experiments the author employed the elastic force of the gases evolved in the electrolysis of water as the compressing agent, and in this way he actually succeeded in reducing oxygen gas to 1-300th of its volume at the ordinary pressure of the atmosphere. He afterwards succeeded in effecting the same object by mechanical means, and exhibited to the Section an apparatus by means of which he had been able to apply pressures which were only limited by the capability of the capillary glass tubes to resist them; and while thus compressed the gases were exposed to the cold attained by the carbonic acid and ether bath. Atmospheric air was compressed by pressure alone to $\frac{1}{371}$ of its original volume, and by the united action of pressure and a cold of —106° F. to 1-675th, in which state its density was little inferior to that of water. Oxygen gas was reduced by pressure to 1-324th of its volume, and by pressure and cold to 1-554th; hydrogen by the united action of cold and pressure to 1-500th; carbonic oxide by pressure to 1-278th, by pressure and cold to 1-——; nitric oxide by

pressure to 1-310th, by pressure and a cold of − 160° F. to 1-680th. None of the gases exhibited any appearance of liquefaction even in these high states of condensation. The amount of contraction was nearly proportional to the force employed, till the gases were reduced to from about 1-300th to 1-350th of their volume; but, beyond that point, they underwent little further diminution of volume from increase of pressure. Hydrogen and carbonic oxide appear to resist the action of pressure better than oxygen or nitric oxide.

LIQUID CARBONIC ACID.

MR. G. GORE has communicated to the Royal Society a paper "On the Properties of Liquid Carbonic Acid."

In this communication the author has shown how a small quantity of liquid carbonic acid may be readily and safely prepared in glass tubes closed by stoppers of gutta-percha, and be brought in a pure state into contact with any solid substance upon which it may be desired to ascertain its chemical or solvent action, or be submitted to the action of electricity by means of wires introduced through the stoppers.

By immersing about fifty substances in the liquid acid for various periods of time, he has found that it is comparatively a chemically inert substance, and not deoxidized by any ordinary deoxidizing agent except the alkali metals. Its solvent power is extremely limited; it dissolves camphor freely, iodine sparingly, and a few other bodies in small quantities; it does not dissolve oxygen-salts, and it does not redden solid extract of litmus; it penetrates gutta-percha, dissolves out the dark brown colouring-matter, and leaves the gutta-percha undissolved, and much more white. It also acts in a singular and somewhat similar manner upon India-rubber; the India-rubber whilst in the liquid acid exhibits no change, but immediately on being taken out it swells to at least six or eight times its original dimensions, and then slowly contracts to its original volume, evidently from expansion and liberation of absorbed carbonic acid; and it is found to be perfectly white throughout its substance. These effects upon gutta-percha and India-rubber may prove useful for practical purposes.

The liquid acid is a strong insulator of electricity; sparks (from a Ruhmkorff's coil) which would pass readily through $\frac{9}{32}$nds of an inch of cold air, would with difficulty pass through about $\frac{1}{70}$th of an inch of the liquid acid.

In its general properties it is somewhat analogous to bisulphide of carbon, but it possesses much less solvent power over fatty substances.

SOLID CARBONIC ACID.

THE Solid Carbonic Acid obtained by the process of Messrs. Loir and Drion is described as a colourless mass, having the transparency of glass. It is easily detached from the sides of the tube in which

it is condensed, and divides itself into large cubical crystals. These crystals, when exposed to the air, resume slowly the gaseous state; they evaporate without leaving any residuum. Placed in the hand, they do not give any sensation immediately of heat or cold, and when taken in the fingers, they escape under a slight pressure, as if they were enveloped in some very oily substance. When taken between the thumb and forefinger, they very soon give a severe burning sensation. Mixed with ether, in a small porcelain crucible, these solid crystals of carbonic acid have made a refrigerating mixture, the temperature of which was 81°, marked on an alcohol thermometer, the melting point of ice being 0°, and 40° the temperature of melting mercury.

MM. Loir and Drion's method of obtaining solid carbonic acid merely requires for its preparation apparatus within the ordinary reach of the laboratory. It depends on the great cold produced by the evaporation of liquid sulphurous acid. Liquid ammonia is placed in a glass vessel, and connected with the receiver of an air-pump by a vessel containing pumice impregnated with sulphuric acid. On exhausting, the temperature of the liquid ammonia rapidly sinks, and it commences to solidify at $-81°$ C.; when the pressure is reduced to 1 millim., the temperature of the liquid ammonia is $-89°·5$. This is sufficient for the liquefaction of carbonic acid under the ordinary atmospheric pressure; for when a current of dry carbonic acid is passed through a U tube dipping in the ammonia, a small portion of it liquefies. By increasing the pressure to some extent, considerable quantities of carbonic acid may be readily solidified.

NEW METALLOID.

Mr. W. Crookes has conjectured from his experiments upon the seleniferous deposit from the sulphuric acid manufactory at Tilkesode, in the Hartz Mountains, that there is a new element belonging to the sulphur group. Its presence was first discovered by the presence of a bright green line in the spectrum of the blue gas-flame. The amount first obtained was only two grains. Its properties, both in solution and in a dry state, are as follows:—1st. It is completely volatile at a red heat.—2nd. From its hydrochloric solution it is readily precipitated by metallic zinc, in the form of a heavy black powder, insoluble in the acid liquid.—3rd. Ammonia added to its acid solution gives no precipitate in coloration.—4th. Dry chlorine, passed over it at a dull red heat, unites with it.—5th. Sulphuretted hydrogen, passed through its hydrochloric solution, precipitates it incompletely, unless only a trace of free acid is present; but in an alkaline solution an immediate precipitation of a heavy black powder takes place.—6th. Fused with carbonate of soda and nitre, it becomes soluble in water. There is little probability that this substance is a compound of two or more known elements. The discoverer believes that the method of spectrum-analysis, adopted to prove that this is a new element, is perfectly conclusive, even when unsupported by chemical evidence.

Mr. Crookes has discovered traces of the new elementary body in two or three specimens of native sulphur, especially some from Lipari; and also in some crude sulphur sublimed from Spanish pyrites. He proposes to give this new substance the name *Thallium* (a budding twig), as the green line which it communicates to the spectrum recalls vividly the beautiful green tint of young vegetation. He supposes that he has obtained a small quantity of the new metalloid in the form of a heavy black powder. A portion of this, so minute as to be almost imperceptible to the naked eye, introduced into the blue gas-flame of the spectrum apparatus, gives rise to a green line of extraordinary purity and intensity, a piece the size of a small pin's head being most dazzling, and quite equal to the yellow line of sodium in brilliancy. For subsequent results see Mr. Crookes's communication to the *Philosophical Magazine.*

DELICATE TEST FOR SULPHUR.

ACCORDING to M. Schlossberger, a solution of molybdate of ammonia in hydrochloric acid, diluted with water, has the property of striking a blue colour with the veriest trace of Sulphur. By means of this test it is said that the presence of sulphur naturally existing in hair and wool may be readily evidenced.

PLATINUM.

PROFESSOR FARADAY has read to the Royal Institution a paper on the Metal Platinum, more especially on the new process devised by MM. H. Ste.-Claire Deville and Debray. In Deville's process the platinum ore is mixed with sulphuret of lead and lead, which by heat forms an alloy fusible at a comparatively low temperature (as was shown); while the iron, copper, and some other impurities combine with the sulphur, and being thus displaced, become oxidized, and remain behind as a slag. The metallic mass is then placed in a small furnace of lime, having apertures to receive the oxyhydrogen blowpipe, and by the agency of its extreme heat, retained by the non-conducting lime, the lead and the other remaining impurities (except rhodium and iridium) are driven off as litharge or in vapour. The heat is then a little raised, and the remaining metal is finally fused—an ingot of above 40 lb. having been thereby produced. The presence of a small quantity of iridium and rhodium is not considered injurious to certain useful properties of the platinum. The lecture was illustrated by a series of instructing experiments. The vaporization of gold, silver, &c., was effected by means of the voltaic battery, and the beautiful green vapour of silver shown on a screen. For a full description of the new process by its authors (with engravings), we refer our readers to Vol. 56 of the *Annales de Chimie*, and to the January number, 1861.

CÆSIUM AND RUBIDIUM.

THE new alkaline metals, and their compounds, are fully described by their discoverers, Bunsen and Kirchhoff, in a paper translated and printed in the *Philosophical Magazine.* In recognition of the importance of their method of analysis by means of the spectrum, the Emperor Napoleon has recently made the former an Officer and the latter a Knight of the Legion of Honour. In relation to this subject we must refer to another paper in the *Philosophical Magazine,* by Mr. J. M. Wilson, Natural Philosophy Master at Rugby, on the "Readings of the Graduated Arc in Spectrum Analysis, and Distortion of the Spectrum," which contains suggestions for determining its limits with greater accuracy.—*Illustrated London News.*

ALUMINIUM AND ITS ALLOYS.

MESSRS. BELL, of Newcastle, have exhibited to the Society of Arts, specimens of the new metal Aluminium and its Alloys. This valuable metal is now produced at a moderate cost, and is being adopted extensively. Some of its alloys possess peculiar properties. That composed of ten per cent. of aluminium and ninety per cent. of copper, is probably the most remarkable. It is a perfect chemical combination, and has no tendency, as is the case with ordinary alloys, to separate under the influence of heat. These proportions represent an exact number of chemical equivalents of the two metals. Aluminium bronzes are of a yellow or orange colour, closely resembling gold, and take a fine polish, equal to that of steel. The chemical properties are the same as those of other copper alloys. In tenacity they fully equal steel. Drawn into wire No. 16 gauge, the breaking strain of copper, according to Mr. Gordon, was 190, of iron 280, of aluminium bronze 434; showing a strain of 84 kilogrammes to the square millimètre. Good French iron, in Deville's experiments, broke at a strain of 60 kilogrammes the square millimètre, and steel wire at a strain of from 90 to 100 kilogrammes. It thus appears that steel, and that of a fine quality, only can stand a comparison with aluminium bronze in respect of tenacity. As regards hardness, a comparison was made between a steel and a bronze groove for the guide box of a locomotive engine, and, after six months' use, no trace of wear was perceptible; the bronze gave a result equally good with the steel. It was also tried for the journals of the front wheel of a locomotive, with excellent results—its great malleability, combined with hardness and tenacity, rendering it well adapted for this purpose, where ordinarily a very brittle alloy is used. The bronze containing 10 per cent. of aluminium can be rolled at all temperatures, from cold up to a bright cherry red. It rolls well at a bright red heat, breaks less and elongates more than pure red copper. It is difficult to roll cold, and, after a number of passes through the rolls, it elongates no further; it is then necessary frequently to reheat it, as it hardens rapidly under the rolls. It is desirable to roll it at as high a temperature as *possible, short of fusion.* Reheating and plunging in water to cool,

renders the alloy more tractable than simply reheating without dipping. If reheated to a bright red heat, and not dipped in water until it has been left to cool in the air down to a low red heat, it is sufficiently malleable and ductile, when cold, to bear, without breaking, the ordinary manipulations in working it, except some descriptions of stamping.

M. Louis le Chatelier has patented an invention which he anticipates will remove the difficulty of obtaining alumina economically. He employs a mode of precipitation which, at the same time that it produces alumina by means of substances abundant in nature or in the arts, gives another substance, which possesses a value sufficient to pay at least a part of the expense of manufacture. He also employs the sulphate of alumina in a state of solution, or paste, without the necessity of bringing it to a solid state. The principal reagents used are magnesia, sea-salt (chloride of sodium), and sulphate of barytes.—*Mechanics' Magazine.*

COMBUSTION OF ALUMINIUM.

M. WÖHLER, the discoverer of this metal, gives the following methods for its combustion:—Conjointly with the leaves of rolled aluminium place a splinter of wood charcoal, so arranged as to touch at once the metal and the wall of the glass vessel; introduce oxygen gas, and heat the vessel by means of a spirit-lamp. Or, roll the leaves of aluminium round a small cylinder of charcoal fixed to the extremity of an iron wire; then light the cylinder and plunge the whole in a jar of oxygen gas. Aluminium leaves inflame spontaneously in chlorine gas.

VARIOUS OXIDES OF MANGANESE

HAVE been produced artificially by M. Kuhlmann, by processes described by him in a paper submitted to the French Academy of Sciences, and printed in the *Comptes Rendus.* Among these artificial products is manganate of lime, a salt remarkable for its decolorizing and disinfecting properties. If this can be economically prepared, a valuable reagent will be more abundantly placed at our disposal.

CEMENTATION.

THE theory of Cementation, or conversion of iron into steel, has undergone a thorough investigation in the hands of several expert chemists. Amongst others, Captain Caron has specially distinguished himself. His experiments were conducted on a large scale. The result of his researches he sums up as follows:—

1. That in industrial cementation, acieration is always produced by means of a cyanide, which is formed naturally in the cementation boxes, by the reciprocal action of carbon, nitrogen, and the alkalies present. It is for this reason that the presence of nitrogen is indispensable.

2. That nevertheless, in certain circumstances, it is possible to cement without the presence of nitrogen, which proves, by the way, that steel is not a nitro-carbide of iron, as some have attempted to demonstrate.

3. That to cement, it is necessary that the agent of cementation be composed of a volatile gaseous carbide compound, but indecomposable at the temperature employed: in this manner the carbon is brought to a state of combination in the pores of the iron, where this metal appropriates it in its nascent state.

4. That native carbonate of baryta mixed with carbon is susceptible of becoming one of the most useful and economical agents of cementation, on account of its unchangeableness and power. Carbonate of strontian produces similar effects.

MM. Frémy and Caron have contributed voluminous papers to the Paris Academy of Sciences, giving the results of laborious researches, and have arrived at certain definite results, which may be summed up in a few words. Steel is not, as has been generally supposed, a simple compound of iron and carbon, but there exist a series of combinations of iron with metalloids, metals, and even with cyanides, yielding steel of very good quality. Ordinary steel contains nitrogen as an essential constituent, for if it be dissolved in acids it leaves a residue different from pure carbon, but closely resembling certain cyanides. That carbon alone cannot effect the conversion of iron into steel is proved by the fact that a current of common coal-gas (carburetted hydrogen), passed for two hours over pure iron at a red heat, carbonizes and converts it into cast-iron of a grey colour, very malleable, and equal to the best specimens produced by charcoal; but when the same gas is passed over iron which contains nitrogen, there is produced steel, the good or bad quality of which depends entirely upon the quantity of nitrogen previously combined with the iron. If the nitrogen and carbon are passed simultaneously over the heated iron, by means of a mixed current of ammonia and coal-gas, the two are then absorbed together, and steel is also the result. Hence, therefore, the process of cementation, instead of being effected, as has been hitherto supposed, by charcoal, is accomplished by the gases accidentally present.

These results are most important. But not only are the results stated in the elaborate memoirs, not new, but, on the contrary, all the essential points—their illustrations, their demonstrations, and even almost their language—have long ago been fully anticipated. M. Frémy (we do not for an instant wish to insinuate that he had any idea of this priority of investigation) has arrived at his deductions without being aware that the whole question had been, nearly four years ago, discussed and exhausted up to, at least, the point he appears to have reached. In a long and elaborate paper which Mr. Christopher Binks read before the Society of Arts, in May, 1857, the author demonstrated, as the result of a vast number of experiments, all that the French chemists now bring forward as new.* Mr. Binks showed that the substances whose application to pure iron convert it into steel, all contain nitrogen and carbon, or nitrogen has access to the iron during the operation; that carbon alone added to pure iron does not convert it into steel; also that nitrogen alone, so added, does not produce steel: but that it is essential that both nitrogen and carbon should be present, and that no case can be adduced of conversion in which both these elements

* See *Year-Book of Facts*, 1858, pp. 59, 60.

are not present and in contact with the iron. He also showed that nitrogen as well as carbon exists substantially in steel after its conversion; and to the presence of these is due the real cause of the distinctive physical properties of steel and iron.

We possess another evidence of the use of nitrogen from another and unexpected quarter; it is on record, as a practice of the Indian "Wootz" steel-maker, that along with his iron or imperfect steel, in his melting crucible, he places, as his carbon-giving material, the wood of the *cassia auriculata,* and covers the whole with the leaves of the *convolvulus laurifolia,* both vegetable productions, rich in nitrogenous matters. These, placed in his closed crucible, will give a nitrogenized carbon in contact with the metal. What is the result? Why the Wootz steel is even now famous for its excellence, and the Sheffield artisan, up to the present day, seeks what the Indian artificer had found out ages ago. This, says Mr. Binks, in commenting on M. Frémy's paper, affords another instance in proof that the laws of matter and its actions are immutable.—*Abridged from the London Review.*

NEW ALLOY.

A NEW Metallic Alloy has been produced by M. Aich, of Brussels. It presents the advantage of working as well cold as hot; it may be forged without losing its cohesion; it melts very readily, and can be afterwards submitted to the operations of hammering, rolling, and punching. It is cheaper than brass, and costs much less than red copper, and may advantageously supersede those metals in shipbuilding; and it will be found advantageous in many other applications to industry, as it possesses more tenacity, and does not so readily oxidize as they do. In the state of homogeneous fusion, it consists of 60 parts copper, 38·2 of zinc, and 1·8 of iron.

ALLOYS OF CADMIUM.

DR. B. WOOD has published his experiments on these alloys. Cadmium in its general characters has a greater resemblance to tin than to other metals. It has less lustre, tarnishes more readily in the atmosphere, is considerably harder, and requires a higher heat for its fusion. It has a sort of milk-white glistening colour, approaching a silver white, with a blue tinge, somewhat like zinc. Its melting point is nearly the same as that of lead; at a low red heat it volatilizes, giving off orange-coloured fumes; at a higher heat it flashes and detonates; if the heat be still raised it bursts into flame with an explosion. It is perfectly malleable, and has considerable tenacity. It does not alloy well with copper, and not at all with nickel. It combines with platinum with a sort of explosion; with silver readily, forming an alloy of fine texture; with gold, however, if properly managed, it unites without hissing, crackling, or detonation, and shows no disposition to volatilize. No sooner is

it brought into contact with the melted gold than the metals seem to leap together, and blend instantly into a homogeneous compound. Rich and varied colours are produced in compounds of cadmium, copper, and silver, in various proportions.

ARTIFICIAL DIAMONDS.

We quote the following from the "Contemporary Science" of the *London Review*:—

The search for "the Philosopher's Stone" seems pretty well to have been discontinued, the progress of research having shown the utter hopelessness of all attempts at the transmutation of metals. If, however, modern scientific opinion forbids philosophers to attempt the conversion of baser metals into gold by other than the legitimate commercial methods, it does not put its veto upon the attempt to transmute carbon into diamonds; and accordingly, since chemistry announced the startling fact that she could perceive no difference between the diamond and charcoal—between the jewel which sparkles on the finger, and the smuts which in London, at least, begrime the face—there has been a continuous series of experimentalists, to whom the artificial crystallisation of carbon into diamond has been the *ne plus ultra* of scientific research. The very simplicity of the problem gives a kind of fascination to the attempts at its solution. The production of elementary substances in the crystalline state is not by any means difficult; a few bodies indeed, carbon amongst the number, have long resisted chemical persuasion, but these have gradually yielded themselves to crystalline influences, until carbon now stands alone. Its two elementary brethren, silicon and boron, are amongst the latest triumphs in this respect, and the exact similarity in physical properties which is observable between the artificial boron and silicon-diamonds and the natural carbon-diamond, shows that philosophers are at last upon the right track, and that any moment may place the fortunate chemist in possession of a discovery rivalling in commercial value that of the long-coveted philosopher's stone. Meantime rumours of the actual solution of the problem are beginning to be heard. Mr. J. Joyce imagined some time ago that he had obtained carbon in the crystalline form, by the action of electricity upon a mixture of carbonic acid and hydrogen. M. Cagniard de la Tour thought that he had obtained some crystals of diamond by fusion, and M. Despretz by the action of electricity upon certain compounds of carbon. But by far the most important result is one just made known by M. Rossi, of Toulon. The experiment was performed by M. Gannal, and consisted in the action of phosphorus, water, and bisulphide of carbon upon each other for several months. Crystals (twenty in number) were thus obtained, which were found to have all the properties of diamond. They were so hard, that no metal would act upon them; they even scratched steel; they were perfectly transparent, and had extraordinary brilliancy; and finally, some of the best formed of them had crystallized in dodecahedra, the crystalline form which is characteristic of the diamond.

NITROGEN.

Dr. Frankland has read to the Royal Institution a paper on the element "Nitrogen," which forms four-fifths of our atmosphere. It can be obtained from the atmosphere by the combustion of phosphorus and other substances; and from its various compounds, nitric acid, &c., especially by heating a solution of nitrate of potash in a concentrated solution of sal ammoniac. It is a colourless transparent gas. A pint of it weighs about ten grains and a half—nearly the same as air. After exhibiting by experiment the different igniting points of various substances, Dr. Frankland asserted that, contrary to the general statement, nitrogen is combustible at 5400° Fah.—

the highest possible temperature of a common fire being about 4000°, and that of candle, oil, and gas flames about 3500°. Hence atmospheric nitrogen does not undergo combustion by exposure to any of these sources of heat. Nitrogen, however, becomes combustible when exposed to the heat of the electric spark, and the combination of oxygen with hydrogen flame. Atmospheric nitrogen is burnt by every flash of lightning. Various compounds of nitrogen with oxygen were next considered, especially nitric acid (aqua fortis), which oxidizes all the metals except gold and platinum, converting them first into oxides, then into nitrates. Among the compounds of nitrogen is nitrous oxide (laughing gas). Nitrogen and hydrogen are incapable of direct combination, but enter into union when liberated from other compounds in the presence of each other, as in the putrefaction and destructive distillation of animal and vegetable substances. Their most prominent compounds are ammonia (or ammoniacal gas) and the hypothetical metal ammonium. The former exists in Preston smelling salts; the latter has only been produced as chloride of ammonium, and an amalgam of mercury. The consideration of the element carbon was begun by burning specimens of its three forms—the diamond, blacklead (or graphite), and charcoal in oxygen gas, and proving the result to be the same in each case—carbonic acid.

DECOMPOSITION OF GUN-COTTON.

M. BONNET has communicated to the Paris Academy of Sciences, certain remarks on the spontaneous Decomposition of Gun-Cotton under the influence of diffused light. The gun-cotton on which he observed this action of light had been prepared in 1856—that is, four years before its decomposition. That which became first decomposed had been prepared with a mixture of nitrate of potash and sulphuric acid, while another sample, which was decomposed later, had been prepared with a mixture of nitric and sulphuric acid. In both cases the decomposition was preceded by the appearance of red vapours; but in the first case the action was much stronger, since the stopper of the phial was forced out, and the neck was cracked. In the same case the residue of the decomposition had the appearance of a substance which had once been liquid, being full of solid bubbles; in the other case, on the contrary, it was compact and strongly agglomerated; in both cases the sides of the phial were covered with small crystals of oxalic acid. The atmosphere of the second phial was acid and attracted water; the acids it contained were carbonic and formic acid.—(See, also, an instance in New York, *Year-Book of Facts*, 1861, p. 183.)

NEW METHOD OF PREPARING NITRATE OF SILVER.

Now that Nitrate of Silver is so extensively used in photography, an easy and unobjectionable method of preparing it becomes desirable. M. Greiner recommends the following:—Dissolve impure silver, *i.e.*, ordinary commercial silver, in nitric acid, and when the

liquid is almost neutral and cold, pour in a solution of sulphate of soda. By this treatment sulphate of silver is thrown down; it is to be collected on a filter, and thoroughly washed with distilled water. Finally let it be digested with an equivalent amount of nitrate of baryta; this gives rise to the formation of sulphate of baryta, separable by filtration, and nitrate of silver, which remains in solution, and may be crystallized.

NEW ACID.

MM. Clœtz and Guignei have discovered a New Acid, which they have obtained from benzine by means of nitric acid; it is remarkable for a fine smell of bitter almonds, and is used to perfume soap with. If boiled with a solution of permanganate of potash, or else with a mixture of nitric acid and bichromate of potash, nitro-benzine absorbs oxygen, and is transformed into an acid, which is solid and soluble in nitro-benzine, with the aid of heat, whence on cooling it is deposited in white crystals. It has no colour, but a hot and bitter taste; it melts at a temperature not more than a common one in summer, and is volatilized without a residue, when it will crystallize again in brilliant and flexible needles. It is not very soluble in cold, but considerably so in warm water, also in alcohol and ether.

OXALIC ACID.

M. F. Pisani has added some further facts to what we knew about the property which oxalic acid possesses of preventing certain reactions by its presence. Thus he shows that if an excess of oxalate of ammonia be added to a neutral salt of iron, and then acetic acid, the yellow colour of the solution will not be changed into red, as it should be, owing to the formation of acetate of iron. Again, in the same solution, phosphate of soda will not precipitate any phosphate of iron; nor will the nitrate of uranium be precipitated by the cyanoferruret of potassium, if oxalate of ammonia be added to the solution.

PHOSPHORUS.

M. L'Abbé Laborde has directed the attention of the Paris Academy of Sciences to these experiments:—

If a dry stick of phosphorus be taken, and its surface be scraped with a knife, and the fragments thus separated be received on a sheet of paper, these small fragments do not change their appearance so long as they remain separate, but when brought together, they become partially fused and run together; the temperature rises, and sometimes spontaneous combustion takes place. If a very thin layer be cut off, after a few seconds the edges of the layer sink and melt, and if the melting proceed rapidly, spontaneous combustion is imminent. The following case is the most likely to occur:—A thin layer of phosphorus having been cut off under water, but not entirely detached from the larger piece, may be taken from the liquid, and dried with a cloth. After drying, the thin layer melts at the edges and may set fire to the larger piece. These results may be obtained at ordinary temperatures. At temperatures below zero, small pieces of phosphorus may be joined together without danger of fusion or spontaneous combustion.

PHOSPHORETTED HYDROGEN.

PROFESSOR GRAHAM has shown that Phosphoretted Hydrogen, although not spontaneously inflammable, becomes so when brought in contact with a small quantity of nitric acid. M. Landolt has furnished an elegant mode of showing this fact. He says, some phosphoretted hydrogen, not spontaneously inflammable, prepared by heating some phosphorus with a concentrated solution of potash with double its volume of alcohol, is directed towards a layer of nitric acid in a capsule. If the acid be about the density of 1·34, and if it is deprived of its hyponitric acid by boiling, the bubbles of phosphoretted hydrogen will traverse it without ignition. But if only a few drops of the fuming acid be added, each bubble of the gas will immediately inflame. Too much of the fuming acid will suspend the action, by decomposing the gas.

NATURE OF THE DEPOSIT WHICH FORMS UPON THE COPPER EMPLOYED IN REINSCH'S TEST FOR ARSENIC.

LIPPERT has made a careful examination of the crust which forms upon bright metallic copper when this is placed in a solution of arsenic acidified with chlorhydric acid. This coating had been pretty generally mistaken for metallic arsenic until Fresenius (in his *Anleitung zur qualitativen Analyse*, 10te Aufl., Braunschweig, 1860, p. 141) called attention to the fact that it contained a large quantity of copper. From the experiments of Lippert, it now appears that the crust in question contains only 32 per cent. of arsenic, 68 per cent. of its weight being copper. This composition having been nearly constant in several specimens which he analysed, Lippert maintains that the compound is a definite alloy, $As\,Cu^5$. When ignited, at the temperature of a combustion furnace, in a current of hydrogen, the compound lost only 7 per cent. of its weight, an alloy of the composition $As\,Cu^6$ (same as that of the mineral Domeykite of F. Field) being formed.

The delicacy of Reinsch's test is evidently directly referable to the large amount of copper which the characteristic coating contains; for a proportionally small quantity of arsenic is thus obtained in an enlarged and, as it were, more tangible form. But, on the other hand, it is not easy to prove in a simple manner the presence of arsenic in this crust; for only a small portion of the arsenic can be volatilized in a current of hydrogen; and even if the alloy be first oxidized in a current of air and then reduced in a current of hydrogen, the per-centage of arsenic only falls from 32 to 20. By far the largest portion of the arsenic is therefore kept out of sight.

For the details of this interesting research, and the author's discussion of the proposition of Reinsch and v. Kobell to estimate arsenic quantitatively by determining the amount of copper which dissolves while the arsenic is being precipitated, we must refer to the original article.—*Journ. für Prakt. Chemie; Philosophical Magazine.*

ARSENIC IN PAPER-HANGINGS.

DR. MACADAM has read to the British Association a paper "On the Proportion of Arsenic in Paper-hangings." He said that in the majority of green paper-hangings arsenic was present in rough powder. He was told that generally flock-paper did not contain arsenic. He exhibited several green papers in which arsenic was deposited in a rough condition. When he struck one of them with his hand a cloud of dust arose; it was arsenic which had been placed over the surface of the paper. In those packages of envelopes where there were twenty-five to each package, eack packet was packed in a band of green paper to keep the envelopes together. If one purchased two packets, or fifty envelopes, there were to be found 2·3 grains of arsenic in the green paper bands. He had found as much as forty grains of arsenic in the square foot of green paper. With regard to the injury which such arsenic papers had upon the system, the injury in no case was carried so far as to lead to actual poisoning.

ARSENIATED ALCOHOL

HAS been employed by M. Leprieur for the preservation of specimens in natural history collections, especially insects. The animal tissues to be preserved should be plunged into the liquor shortly after death, and the insects while still living, or after suffocation by chloroform or ether vapour. M. Leprieur, who has so successfully employed this method for twelve years, adds, that the living insects are increased in weight about a fourth, after remaining in the liquid twelve hours, and that they retain in their organs quite enough arsenious acid to repel the attack of larvæ.—*Journal de Pharmacie.*

DANGEROUS COSMETICS.

DR. RÉVEIL, in a paper read to the Paris Academy of Medicine, shows the necessity of preventing perfumers from selling poisonous or dangerous articles, which should be left exclusively to the responsibility of regular chemists, and not sold without a physician's prescription. Arsenic, the acid nitrate of mercury, tartar emetic, cantharides, colchicum, and potassa caustica are general ingredients in these cosmetics. Lettuce soap, pretended to be sold under the sanction of the Academy, does not contain the slighest trace of lettuce. This and other soaps are coloured by the sesquioxide of chromium, or of a rose colour by the bisulphuret of mercury, known as vermilion. The cheaper soaps contain 30 per cent. of insoluble matter, as lime or plaster; while others contain animal nitrogenous matter which, having escaped the process of saponification, emits a bad smell when its solution is left exposed to the air. The various toilet vinegars are so far noxious, that being applied to the skin *still impregnated* with soap and water, they give rise to a decompo-

sition, in consequence of which the fatty acids of soap, being insoluble in water, are not removed by washing, become rancid, and cause chronic inflammation of the skin. The hair dyes, African Water, Florida Water, &c., all contain nitrate of silver, sulphur, oxide and acetate of lead, sulphate of copper, and other noxious substances. All cosmetics for removing hair or freckles are dangerous: the *lait antéphélique*, for instance, contains corrosive sublimate and oxide of lead. Were a chemist in France to deliver such a remedy to a customer without a regular prescription, he would be liable to a fine of 6000 francs.

CURE FOR SERPENTS' BITES.

THE celebrated French anatomist, Jules Cloquet, has just communicated to the Paris Academy of Sciences the contents of a letter forwarded to him from the Philippine Isles by M. de la Gironnière, in which some curious particulars are given respecting the cure of a man who been bitten by a most deadly serpent. It seems that the Philippine Islands swarm with venomous snakes, the bite of which often proves fatal to the woodmen. One of the most venomous of these serpents has only a length of from fifteen to twenty inches. Its head is flat and triangular, like the head of most poisonous serpents, and altogether it has a most wicked, forbidding look. One of these creatures, M. de la Gironnière relates, bit a man in the hand. Violent pains set in, and the swelling had extended quite up to the shoulder before M. de la Gironnière was consulted. He had no ammonia by him (an acknowledged remedy for the bite of venomous snakes), so all that occurred to him to do was to effect a cauterization of the part with live coals, which was immediately carried into execution. The remembrance came to him, however, that he had heard of good results produced by the administration of alcohol; and a bottle of native brandy lying beside him, he made the patient swallow the whole of it, which caused him almost immediately to fall down inebriated. At the end of about half an hour, recovering partially his senses, the pains returned, whereupon another bottle full of brandy was administered, and finally a third, by which treatment he fell intoxicated once more; and, on arousing from his spirituous slumbers, the pain, and other evil symptoms of the snake-bite, had gone. This statement comes well accredited.

Liquor Ammoniæ (a solution of ammonia) has been long known as a remedy for snake-bites, but in some cases it is said to be injurious. In a recent Bombay paper we find authenticated accounts of its having beem employed with great efficacy for this purpose, four hundred cases of cure from the deadly bites of venomous serpents having been recorded. The authorities are consequently endeavouring to supply the natives with the medicine and instructions for its use at a cheap rate.

PREVENTIVE FOR HYDROPHOBIA.

DR. RODET, late chief surgeon of the Antiquaille, at Lyons, having remarked that a solution of perchloride of iron, applied as a topic, was extremely useful in the treatment of certain disorders, was induced to try it also in the cow-pox, and found, as he suspected, that the perchloride destroyed that virus completely. Encouraged by these results, he determined to try its effect on the virus of hydrophobia, and with this view a series of experiments was made at the Veterinary School at Lyons, from which it appears that the solution of perchloride of iron destroys the virus of hydrophobia with certainty, if applied within two hours of the infliction of the bite. It is highly probable that the effect would be the same if the remedy were applied four, six, or even eight hours later, but this requires confirmation by further experiment. Admitting that Dr. Rodet's discovery may be relied on, its importance cannot certainly be overvalued; for, although the actual cautery is exceedingly prompt, nay, instantaneous in its action, it is often difficult to apply it, either owing to the trepidation of the patient, or to the dangerous position of the wound; and, on the other hand, it may often be easier to find the solution of perchloride at a chemist's, in the country especially, than a skilful operator to apply the red-hot iron unflinchingly to the injured part.—*Galignani's Messenger.*

PREVENTING BEER FROM TURNING SOUR.

WE have the following from reliable authority:—A French chemist has discovered a chemical compound, by which, upon the addition of a quantity of it, according to the quantity of beer operated upon, it prevents the beer passing into the acetous fermentation, and keeps it in a perfectly sound condition for an almost indefinite space of time, no matter the quality of the materials used in its manufacture; but as beer, &c., are exciseable articles, and the penalties heavy if found adding any substance otherwise than allowed, the discoverer goes to the Board of Inland Revenue, states the discovery he has made, wishing to know if any brewers using it would be prosecuted. The Board reply by saying it must receive a searching analysis by their chemists, to see whether it would be injurious to the consumers. In a subsequent communication from the Board, a reply is given that it possesses no injurious properties, and he is allowed permission to use it. He is about getting a patent for it, as to have used it without the sanction of the Board, prior to obtaining a patent, would have subjected him to heavy penalties.—*Chemical News.*

FLOATING MARINERS' COMPASSES.

FOR this purpose recourse has been had to fresh and salt water and alcohol. The first of these freezes, the chlorine in the second attacks the metal, and the third evaporates too readily. M. Sante, a mathematical instrument maker at Marseilles, has had the happy

idea of employing glycerine, in which, he states, he has perfectly succeeded.

ON FERMENTATION.

M. PASTEUR has for a considerable length of time been engaged in a research on the nature of Alcoholic Fermentation, a complete account of which he has published in the *Annales de Chimie et de Physique*.

According to Pasteur, *alcoholic fermentation* is the peculiar transformation which sugar experiences under the influence of beer yeast. The author shows that glycerine and succinic acid are products of the alcoholic fermentation, and treats of their estimation and separation.

The details are given in the *Philosophical Magazine*, No. 138. We have only space for these results :—

Permanent Vitality of Yeast.—When yeast is mixed with a proportionally small quantity of sugar, after the latter has been decomposed, the activity of the yeast continues, but is turned upon its own tissues with an extraordinary energy and rapidity; a weight of alcohol and carbonic acid is thus obtained, exceeding that which the sugar could yield. Under these conditions the following facts are observed :—

1st. The action of the yeast is first exerted on the sugar.

2nd. The yeast reacts on itself when the sugar has been completely destroyed.

3rd. The effect produced by the yeast on itself is not proportional to the weight of the yeast.

The author assumes that the globules formed by the fermentation of the sugar cannot attain their complete development for want of sufficient sugar, and that the young globules needing this nourishment live at the expense of the parent globules,—which produces a secondary fermentation, or the yeast destroys itself.

Lastly. M. Pasteur speaks of the application of some of the results to the composition of fermented liquors.

Since glycerine and succinic acid are constant products of the alcoholic fermentation, they ought to be found in wine, beer, cider, &c. This the author has already shown to be the case.

M. Pasteur terminates by the following passage, containing the fundamental conclusion which he draws from his important researches :—"As to the interpretation of the whole of the new facts which I have met with in my researches, I think that whoever considers them impartially will see that fermentation is a correlative act of life, and of the organization of globules, and not of death or the putrefaction of these globules; still less does it appear to be a phenomenon of contact, where the transformation of sugar proceeds in the presence of the ferment without yielding anything to it, or taking anything from it."

ALCOHOLOMETERS.

M. POUILLET has presented to the Paris Academy of Sciences, on behalf of the Committee upon Alcoholometers, the Report so long expected. The task imposed upon this Committee was a very important and a very difficult one. They had to ascertain by numerous very delicate experiments, the correctness of the value given by Gay

Lussac as the density of pure alcohol. They had also to ascertain whether the densities of different mixtures of alcohol and water used by him for the construction of the centesimal alcoholometer were exact, proving that the theory upon which this instrument is constructed is well founded. It is, however, when we descend from theory to practice, that the construction of the alcoholometer appears surrounded with difficulties. 1st. It is very difficult to obtain tubes of sufficient length that are perfectly uniform in bore, and to make their graduation perfectly exact. 2nd. The graduation changes in time, zero being displaced as in the thermometer. 3rd. It is very easy to transform an alcoholometer which is exact in its indications into one which is systematically false in its indications. 4th. In cases of fraud which may occur very easily, their detection and repression would be impracticable. In reply to the question proposed by the French Government, whether the law of 1847 should be applied to alcoholometers, requiring them to be stamped as a guarantee of their correctness, the Commission replied, that besides the difficulties of putting the plan in practice, it would be attended with more and greater disadvantages than advantages, especially as the Government stamps might be used to cover or sanction fraud. This was the unanimous opinion of the Commission, and the Academy of Sciences accepted it without discussion, and confirmed it by an almost unanimous vote.

THEORY OF DISSOCIATION.

Dr. Thomas Woods has communicated to the *Philosophical Magazine*, some Remarks on Sainte-Claire Deville's Theory of Dissociation, which is shown to be nearly the same as that published by Dr. Woods in the *Philosophical Magazine*, in January, 1852: he does not agree with what is new in Sainte-Claire Deville's paper: he thinks that compound gases and vapours, when heated to a certain temperature, as steam at 1000°, undergo some such change as a solid body does when it liquefies; that the *constituent* particles being removed from each other, as well as the compound particles, the gas loses *stability*, and that heat is rendered latent thereby. This condition he calls the *dissociated* state.

We have only space for the conclusions of Dr. Woods, who considers the above state of *dissociation* altogether founded on gratuitous assumptions :—

The ground from which it springs is this; that as compound bodies when heated expand, the constituents must recede from each other as well as the compound particles. But this proposition has yet to be proved. Dr. Woods believes many facts favour an opposite conclusion: for instance, not to speak of the manner in which solids and fluids, when *simple* bodies, expand, being somewhat similar to the same process in *compounds*, Gay Lussac's law with respect to the equal expansion of all gases and vapours for equal increments of heat, would surely show that the constituents of a compound do not recede from each other in expanding. Hydrogen, or any other simple gas, and vapour of ether, or other compound gas, expand exactly according to the same law. Could this occur with the simple particles of hydrogen to the same extent precisely as with *compound molecules* of ether, where, instead of two, we have ten elementary

atoms to divide the distance and moving force between them? The resistance to expansion of a gas by heat seems to be the weight of the atmosphere; and consequently in all gases, the same resistance being present, the same expansion is attained by a certain increase of temperature. Now in a simple gas the weight is the only resistance; whereas, if Deville's theory is correct, there is in compound gases not only the weight, but the affinity of the constituents to be partly overcome; and yet the same expansion is noticed for the same increase of temperature in both. But this would be impossible, except we imagine that the separation of these constituents does not absorb heat, which we know it does.

It seems to Dr. Woods that this fact alone, of the similar and equal expansion of simple and compound gases by heat, shows that no motion takes place in one which does not occur in the other; therefore that no expansion of the particles themselves, that is, that no separation of the simple constituents of the compound molecule is produced by raising its temperature, and consequeutly that this state of *dissociation* does not exist.

THE BOILING-POINTS OF DIFFERENT LIQUIDS.

THE laws relating to the Boiling-points of Different Liquids at the ordinary pressure of the atmosphere have lately been investigated by Mr. Tate, and the results of his experiments are published in the *Philosophical Magazine.* He has made experiments with solutions containing the chlorides of sodium, potassium, barium, calcium, and strontium; the nitrates of soda, potassa, lime, and ammonia; and the carbonates of soda and potassa. He has found for all these salts that the augmentation of boiling temperature may be approximately expressed in a certain power of the percentage of the salt dissolved. The salts enumerated may be divided into four distinct groups; namely, first, the chlorides of sodium, potassium, and barium, and the carbonate of soda; second, the chlorides of calcium and strontium; third, the nitrates of soda, potassa, and ammonia; fourth, the carbonates of potassa and nitrate of lime. In each of these four groups the augmentations of boiling temperature of the solutions have a constant ratio to one another for an equal weight of salt dissolved. He has also ascertained by experiments that for an equal weight of salts, the boiling temperatures are (approximately) in the inverse ratio of the chemical equivalents of their bases, and in the case of the nitrate of lime and the carbonate of potassa with the equivalents of the entire salts. Although the law thus indicated is not strictly true, it is sufficiently exact to warrant further inquiry, and the cases in which it is found to apply are too numerous to be referred to accidental coincidence. Future researches may extend these laws to other substances, as it is quite consistent with analogy to suppose that the chemical composition of a substance affects the boiling temperature of its solution. It will readily be acknowledged that the prosecution of these experiments may throw additional light upon the generation of steam, the economy of fuel, and kindred questions of great practical importance to engineers.—*Mechanics' Magazine.*

SPHEROIDAL CONDITION OF WATER.

M. DUMAS has announced that M. Sudre has confirmed by experiment beyond doubt the curious and important fact signalized by M. Boutigny d'Evreux, that the temperature of a globule of water in the spheroidal state is between 205 and 206 deg. Fahrenheit, consequently below that of boiling water. M. Sudre's mode of experimenting consists in introducing the globule of water into a calorimeter and determining its temperature by the quantity of ice it dissolves. This statement has been made to the Paris Academy of Sciences.

M. de Luca having on a previous occasion announced to the Academy that the iodide of starch, when in a spheroidal state, did not lose its colour, and that consequently its temperature would not exceed 80, or perhaps not 50, degrees Centigrade, and M. Boutigny having remarked quite a contrary effect, the latter was induced to examine what could be the cause of such a wide difference in the results of the same experiments; and he has found it in the quantity of iodine, and in the duration of the experiment. When the iodide of starch contains 1-200th part of iodine, it may be brought to the point of ebullition without being discoloured. In that case, however, he considers the temperature to be 96½ degrees.

SALINE IMPURITIES OF WATER.

DR. FRANKLAND has read to the Royal Institution, a paper on the "Saline Impurities of Water, principally Salts of Magnesia, Lime, Potash, and Soda." He showed how several of these, which are insoluble in pure distilled water, are soluble in water containing carbonic acid gas, and are thus held. By means of soap-test (soap dissolved in alcohol) he showed the several degrees of hardness of various waters. A permanent lather was obtained in distilled water by a very little of this test; a larger quantity was required in the water supplied to the Institution; and in water containing sulphate of soda a lather could hardly be obtained at all. Chemists reckon degrees of hardness by the number of measures of soap-test required to produce a lather. By means of caustic lime hard water is softened in large quantities at Plumstead, near Woolwich. Water is softened by boiling, and also by adding a small quantity of carbonate of soda. A very little soda need be added to hard water for washing the skin. By Normandy's process pure water is distilled from sea-water, and afterwards aërated. Organic impurities in water are the worst to deal with, being generally in an oxidizing—*i.e.*, a fermenting—state, and thus very apt to create disease. They are of animal and vegetable origin—the former being the worst. We have a simple test for them in permanganate of potash, which gives a strong pink tinge to pure water. This tinge is lost when the test is poured into water containing much organic matter. A few drops of the test coloured some distilled water; but some clear water, contaminated by the neighbourhood of sewage, could not be coloured with any amount of the test. The companies supply, generally, pure water,

the hardness in which is not altogether injurious, as it prevents the water dissolving the lead of the pipes. Tinning pipes was shown to be dangerous, as a voltaic current might be established by the two metals, and thus the lead be much more rapidly corroded than when the pipes are not tinned. The supply of water by the constant system was advocated, as water stored up in cisterns is very apt to absorb deleterious gases. The lecture was concluded with some remarks on ozone, an odorous principle in the atmosphere, observed after the electric discharge from the machine and after lightning, and which can be produced by phosphorus in moist air. Its presence is manifested by imparting a blue tinge to papers coated with a preparation of iodine and starch. Many chemists consider ozone to be a teroxide of hydrogen. Dr. Frankland asserts that the usual test for ozone in the air is quite valueless. The blue tinge may be given by other substances, and the presence of ozone in the air has not yet been proved.—*Illustrated London News.*

COLOURING MATTER OF WOADS.

MM. Schatzenberger and Paraf have made to the Paris Academy of Sciences, a communication on lutéoline, the Colouring Matter of Woad. This substance, first extracted by M. Chevreul, had not yet been analysed, owing probably to the difficulty of procuring it in sufficient quantities by M. Chevreul's method. The authors of the paper in question have therefore invented a new mode of preparation. The woad is first exhausted by alcohol, the solution thus obtained is precipitated by water, and the precipitate is then heated in water raised to a temperature of 250 degrees Centigrade (two and a-half times that of boiling water) in a cylinder of cast steel, closed by a steel screw. After the liquid has cooled, the inner surface of the cylinder is found covered with yellow crystals in the form of needles, and at the bottom there is a button of resinous matter. These crystals when purified and analysed, yield 62·5 of carbon, 3·8 of hydrogen, and 33·7 of oxygen per cent.

IMPROVEMENTS IN THE MANUFACTURE OF SUGAR.

M. Dumas has introduced to the Paris Academy an important discovery in the Manufacture of Sugar, lately made by M. Rousseau. The following is an outline of this invention:—

The juice of the beetroot, to become sugar, requires to undergo three essential operations; that is to say,—

1st. That which deprives it of its fermentative matter.

2nd. The process of bleaching.

3rd. The process of driving out the water contained in the juices, and which leaves the sugar in crystals, such as we use it.

Up to the present time, the first of these operations is performed with the assistance of quick lime.

The second—animal charcoal.

And the third, by means of a very expensive apparatus, called a vacuum pan. There are so many and so serious objections to quick lime that it is impossible to enter upon them here. M. Rousseau replaces it by ordinary plaster (plaster of Paris), *a cheap substance,* and easy to manipulate.

Animal charcoal is the pest of manufactories, being very dear and expensive to manipulate. This is replaced by a peroxide of iron, or "common rust," with which every one is acquainted.

The vacuum pans are very expensive, both in their first outlay, and to keep in order. M. Rousseau replaces these by ordinary evaporating cauldrons.

The experiments made in the laboratory leave nothing to desire. It now only remains to prove the result on a large scale of manufacture. Europe alone makes 350,000 tons annually, and agriculture alone furnishes the raw material. On account of the large amount of capital required, there exist, relatively speaking, but few of these establishments; but, from the moment when, with a capital of 1000*l.* to 1500*l.*, one can erect a manufactory, their increase will be rapid, and the consumer, as well as the manufacturer, will profit by this great discovery.—*Mechanics' Magazine.*

EXHAUSTION OF SOILS.

A PAPER has been read to the British Association, "On some Points in Connexion with the Exhaustion of Soils," by Mr. J. B. Lawes and Dr. J. H. Gilbert. The question of the exhaustion of soils is one of peculiar interest at the present time, not only on account of the great attention now paid to the waste of manuring matters discharged into our rivers in the form of town sewage, but also from the fact that Baron Liebig has recently maintained that our soils were suffering progressive exhaustion from this cause, and predicts certain, though it may be distant, ruin to the nation, if our modes of procedure be persevered in. The question was one of chemical facts; and the authors had it in view to treat it much more comprehensively than they were enabled to do on the present occasion. They proposed, by way of illustration, to bring forward one special case of progressive exhaustion, occurring in the course of their own investigations, and then to contrast the conditions of that result with those of ordinary agriculture. They had grown wheat for eighteen years consecutively on the same land, both without manure and with different constituents of manure, and they had determined the amounts of the different mineral constituents taken off from each plot. Numerous tables of the results were exhibited.

It was, of course, impossible to state the limits of the capability of soils generally, so infinitely varied was their composition; but it would be useful to give an illustration on this point. Taking the average of forty-two analyses of fourteen soils, of very various descriptions, it was estimated that it would require, of ordinary rotation with home manuring and selling only corn and meat, about two thousand years to exhaust the potash, about one thousand years to exhaust the phosphoric acid, and about six thousand years to exhaust the silica, found to be soluble in dilute hydrochloric acid, reckoning the soil to be one foot deep. In conclusion, whilst the authors believed that modern practices did not tend to exhaustion in *anything* like the degree that had been supposed by some, they *would, nevertheless,* insist upon the importance of applying to

agricultural purposes as much as possible of the valuable manuring matters of our towns. It was at the same time certain, that if these were to be diluted with water in the degree recognised under the present system, they could then, unless in exceptional cases, be only applicable on the large scale to grass land; and, so far as this was the case, they would, of course, not directly contribute to the restoration to the land under tillage of the mineral constituents sent from it in its produce of corn and meat.

PARAFFINE.

MR. CHARLES TOMLINSON, in a paper communicated to the Society of Arts, "On Paraffine," observes :—"It was long supposed that the paraffine of tar, and of certain mineral substances used for the production of heat and light, was not a natural product, but one entirely due to the artificial action of heat upon those substances; but as Professor Bolley has pointed out (*Mem. Chem. Soc.*), masses of naturally separated paraffine have been found in deposits of rock oil, at Borystow, in Galicia, while the minerals ozokerite, sheererite, idrialin, &c., show that hydro-carbons differing considerably in melting point and chemical composition, occur ready formed in nature. Professor Bolley has also detected paraffine ready formed in bog-head shale, by exhausting it with various re-agents. A kilogramme of the pulverized shale yielded to alcohol 2·14 parts of solid extract residuum, and to ether, after drying, 2·63 parts. The latter was unctuous to the touch, and not very deeply coloured; it could be re-dissolved in ether, and decolorized by agitation with animal charcoal. The residue then exhibited by elementary analysis a quantity of oxygen amounting to 11 per cent., and gradually turned yellowish when heated for some time in a water-bath above its melting-point. It sustained a loss by boiling with soda-lye, and the undissolved portion melted at 41° C. It remained colourless when heated, solidified in crystalline lammæ, was insoluble in water, sparingly soluble in alcohol, somewhat more soluble in ether. The analysis of this residue gave :—

Carbon	86·33 per cent.
Hydrogen	13·32 ,,
	99·65

Professor Bolley thinks it probable that paraffine exists as such in several of the materials from which it has hitherto been prepared by destructive distillation, and he submits the above process of separation as a convenient method of testing such substances with reference to their utility for the preparation of paraffine. Remarking on the common statement that the non-existence or rarity of paraffine in coal tar is due to the great heat employed in the distillation, he suggests that it is rather because true coal does not contain paraffine ready formed, and therefore cannot yield a tar containing paraffine. On examining two sorts of coal by this method, he obtained, *not* paraffine, but an extract of the nature of asphalte.

The following additional new facts respecting paraffine are worthy of record :—

A New Use for Paraffine.—Every chemist has experienced the annoyance of finding the stopper of his liquor potassæ bottle hard set. Greasing the stopper would only afford a partial remedy, and, moreover, would be objectionable chemically, inasmuch as the liquor potassæ would suffer contamination. Paraffine is unobjectionable; not only does it not dissolve in alkaline leys, but its lubricating properties are sufficient to prevent all jamming of the stopper.

Mr. Herapath, of Bristol, in a letter to the *Times*, writes :—

"So many accidents have occurred from the explosive character of an oil that has been sold as paraffine or petroline, that I think it advisable to make the public acquainted with an easy method of proving whether the oil is dangerous or not. Let two or three drops of it be allowed to fall upon a plate or saucer, and apply to them a lighted match; if the flame spreads over the surface of the drops the oil should on no account be used, as it will under many circumstances prove explosive. The genuine paraffine or petroline will not burn except upon a wick."

In a valuable article on Photogen, by Mr. Greville Williams, in the last edition of *Ure's Dictionary*, is a table showing the materials employed for distilling the oils, with the per-centage of tar and of the oils and of paraffine. The raw material consists of Trinidad pitch, the bog-head coal, and torbane mineral of Scotland, Dorset shale, Belmar turf from Ireland, George's bitumen from Neuwied, paper coal and brown coal from various parts of Germany, and Rangoon tar. But of all the substances hitherto employed none are so rich in results as the last.

The death of two persons from an accidental ignition of paraffine oil has again raised the question of its inflammability. In the report of the inquest, it is stated that the oil is not inflammable without a wick, and that it cannot be fired by dropping a light into it. The same statement was made in the month of October, 1859, when there was an inquiry before the coroner for the City into the cause of the fire at the warehouse of the Paraffine Oil Company in Bucklersbury; but it was proved that the oil would ignite in this manner, and that this, indeed, was the actual cause of the fire in the Company's warehouse. At that inquiry the properties of the oil were carefully investigated by two chemists of eminence—namely, Mr. Warrington and Dr. Letheby, and they both declared the oil to be dangerous; Dr. Letheby, indeed, showed by experiment in court that a piece of lighted paper would fire the oil when dropped into it, and both the chemists proved that the oil gave off inflammable vapour at a temperature of 160 deg. of Fahrenheit. The result of that inquiry was that the jury declared the oil to be dangerous from its inflammability. That the discovery of the mode of manufacturing this oil, and the use of it for illuminating purposes, is a great boon to the public there can be no doubt, but in proportion to its value is the necessity for guarding against accident from it. It appears that the danger arises from two causes—namely, the leaving of a large portion of the more volatile part of the oil in it before it is sent into commerce, and,

secondly, the use of a spurious oil, which, like benzole or coal-naphtha, is highly inflammable. With proper precautions both of these sources of danger may be avoided.

CHEMISTRY OF BLOOD.

M. Denis has communicated to the Paris Academy of Sciences a continuation of his researches. About three years ago, he extracted from Blood a substance which he has named "plasmine," because it possesses the property of solidifying without the intervention of any appreciable cause, and probably plays an important part in the economy of the living animal. He has obtained this remarkable substance from the blood of men, calves, and oxen. Its solubility in water is probably due to its containing a little common salt. When submitted to the action of alkalies or acids it becomes an albuminoid. The last fibrine, which constitutes the albuminous part of the globules of venous blood, M. Denis terms "globuline."—*Comptes Rendus.*

SECRETION OF THE HUMAN PANCREAS.

Mr. W. Turner has communicated to the Royal Society of Edinburgh a paper "On the Properties of the Secretion of the Human Pancreas." The author obtained the pancreatic secretion at a *post-mortem* examination which he made of the body of a patient of Mr. Spence, who had died with a medullary tumour in the head of the pancreas, which, by compressing the biliary and pancreatic ducts, had produced dilatation of the ducts of the liver and gall-bladder, as well as dilatation of the ducts and lobules of the pancreas. The secretion was contained in the dilated parts of the gland last named, from which it was drawn off by means of a pipette. The fluid thus obtained was of an orange-yellow colour, and well-marked viscid consistency—sp. gr. 1·0105; appearance slightly turbid, owing to the presence of small white flakes, which a microscopic examination proved to consist of groups of small spherical, colourless cells, resembling, and most probably consisting of, the epithelial lining of the vesicles of the gland. Reaction faintly, yet decidedly, acid; heat, alcohol, corrosive sublimate, and bichloride of platinum threw down copious yellowish-white precipitates, consisting of the peculiar albuminous constituent of the secretion. No reduction was effected by boiling the fluid with freshly precipitated blue oxide of copper, showing the absence of sugar or any corresponding deoxidizing substance. The absence of sulpho-cyanide of potassium was shown by no reaction being given with a solution of perchloride of iron; thus affording a well-marked distinction between the composition of the human saliva and pancreatic juice. A partial emulsionizing effect was produced by rubbing some of the fluid with a little oil. With another portion of the secretion, starch was converted into dextrine. The action of the fluid upon albuminous substances was also tested, but a negative result was obtained. It should be stated, however, that but a small quantity of

the secretion was now left, and that a day had elapsed between its withdrawal from the body and the application of this test. The author then adverted to the accounts which have been given by various physiologists of the pancreatic fluid obtained from the different domestic animals which it is usual to experiment on when samples of this secretion are required, and concluded by showing in what respect the secretion of the human pancreas agreed with, or differed from, that of these animals.

SPONTANEOUS GENERATION.

MM. JOLY AND MUSSET have sent to the Paris Academy of Sciences, further researches on Spontaneous Generation, a theory which they support. Their paper contains a description of certain new experiments of their own, from which it appears that whatever precaution may be used to destroy the germs said to float in the air, by heating it, and making it pass through concentrated sulphuric acid, and no matter how long the organized substances experimented upon have been exposed to ebullition, the vessels in which the operations have been conducted will be found to contain organized productions which cannot have been introduced by atmospheric air.

TREATMENT OF CROUP.

IN this dangerous disease, certain practitioners in France have endeavoured to rid the trachea of the false membranes which encumber it, either by mechanical or by chemical means. Dr. Ozanam has communicated to the Paris Academy of Sciences a series of numerous experiments made with different chemical agents not hitherto tried, and from which we select the following:—The chloride of potassium dissolves the false membranes completely in twenty-four hours; chloride of sodium in thirty-six; a solution of one hundredth part of bromide of potassium in water in twelve hours; a mixture of bromine and bromide of potassium is more powerful still. One part of chromate of potassium in ten of water will harden the membranes in the course of two days. The sub- and bi-carbonates of potash, in concentrated solutions, will dissolve the membranes in twelve hours. Phosphate of soda is less active; the cyanide of potassium in a concentrated state will dissolve the membranes in fifteen hours; pure glycerine will soften them in twenty-four hours; but the mother water of wrack soda will effect a complete solution in four or five hours. Dr. Ozanam concludes from his experiments that, if it be intended to attack the membranes by dissolvents, alkalies should be preferred; and from what we have quoted above it will appear that the sub-carbonate and chlorate of potash and the phosphate of soda, so long advocated, are the lowest on the list in point of efficacy. If, on the contrary, segregation or separation be aimed at, then chloride of bromine, bromine itself, and chlorine, or else iodine, perchloride of iron, and chromium, should be resorted to, since they harden the membrane, and make it detach itself. These

conclusions acquire great value from the fact that Dr. Ozanam has been pursuing these researches since 1849. He quotes a singular instance of a cure which occurred in 1860. A country physician having, in a case of croup, attempted to cauterize the false membrane by stick-caustic, the patient, somehow or other, swallowed the whole piece. In an agony of terror the practitioner forced a concentrated solution of kitchen salt (hydrochlorate of soda) down the patient's throat by way of antidote, and, to his surprise, not only saved him from the effects of the caustic, but also cured him of his croup by the same simple remedy.—*Galignani's Messenger.*

ENAMELLING ON GLASS.

M. F. JOUBERT has communicated to the Society of Arts "A New Method of producing on glass, Photographs, or other Pictures, in Enamel Colours."

For this purpose (says M. Joubert), I proceed in the following way:—A piece of glass, which may be crown or flatted glass, being selected as free from defect as possible, is firstly well cleaned, and held horizontally while a certain liquid is poured on it. This liquid is composed of a saturated solution of bichromate of ammonia in the proportion of five parts, honey and albumen three parts of each, well mixed together, and thinned with from twenty to thirty parts of distilled water, the whole carefully filtered before using it. The preparation of the solution, and the mixing up with other ingredients, should be conducted in a room from which light is partially excluded, or under yellow light, the same as in photographic operating rooms, so that the sensitiveness of the solution may not be diminished or destroyed.

In order to obtain a perfect transfer of the image to be reproduced, the piece of glass coated with the solution, which has been properly dried by means of a gas stove (this will only occupy a few minutes) is placed face downwards on the subject to be copied in an ordinary pressure frame, such as are used for printing photographs.

The subject must be a positive picture on glass, or else on paper rendered transparent by waxing or other mode, and an exposure to the light will, in a few seconds, according to the state of the weather, show, on removing the coated glass from the pressure frame, a faintly indicated picture in a negative condition. To bring it out, an enamel colour, in a very finely divided powder, is gently rubbed over with a soft brush until the whole composition or subject appears in a perfect positive form. It is then fixed by alcohol, in which a small quantity of acid, either nitric or acetic, has been mixed, being poured over the whole surface and drained off at one corner.

When the alcohol has completely evaporated, which will generally be the case in a very short time, the glass is quietly immersed, horizontally, in a large pan of clean water, and left until the chromic solution has dissolved off, and that nothing remains besides the enamel colour on the glass; it is therefore allowed to dry by itself near a heated stove, and when dry is ready to be placed in the kiln for firing.

It may be stated that enamel of any colour can be used, and that, by carefully registering, a variety of colours can be printed one after the other, so as to obtain a perfect imitation of a picture; also the borders of any description can be subsequently added, such as those shown in the specimens on the table, without any liability to remove or even diminish the intensity of the colour in the first firing.

It will be easy to perceive that this mode of obtaining an image on glass, in an absolutely permanent substance, and of any description, colour, or size, may prove of considerable advantage and utility for the decoration of private houses, and also for public buildings. Through means of the photographic art, the most correct views of any object or of any building or scene—even portraits—can be faithfully and easily obtained.

Natural History.

ZOOLOGY.

LIMITS OF SPECIES.

THERE have been read to the British Association, "Notes on the Variation of *Tecturella grandis*," by P. P. Carpenter.

Prof. Williamson observed, that it was facts like those brought forward by Mr. Carpenter that were wanted to test the limits of species. Amongst the Foraminifera he had long been acquainted with the extreme difficulty of determining the limits of particular species. The Darwinian theory had made it necessary to study every individual form, so that no species should rest on characters obtained by the absence of intermediate forms. The Hon. W. Elliott pointed out the extreme difficulty of referring some of the Carnivora and Quadrumana of India to the described species on account of intermediate forms. He instanced the *Viverra Tibetica* and the *V. Bengalensis*. Prof. Babington said, that nothing could be more disastrous for science than the giving up the study of individual forms. If the Darwinian theory led to the abandonment of our present idea of a species, it ought to lead us to be much more exact in the study of individual forms.

ETHNOLOGY AND PHYSICAL GEOGRAPHY.

MR. J. CRAWFURD has read to the Ethnological Society a paper "On the Connexion between Ethnology and Physical Geography," in which he pointed out the constant relation met with in the barbarous or civilized conditions of the races of man in proportion to the quality of the race and the physical character of the country to which it belonged. Mere intemperance of climate was sufficient to prevent a race from making any advance towards civilization, as was to be seen in the condition of the inhabitants of the Arctic and Antarctic regions; while some lands, such as Spitzbergen and Nova Zembla, seem incapable of supporting human life at all. The absence of mountains and large rivers, and the obstacles presented by the great growth of forests, were exhibited in the characters of the effete Australians, and the tropical Andaman Islands exhibited a race of small abject savages, among the lowest in the world, while they were at no considerable distance, on the one hand, from the handsome and civilized Hindoos, and on the other, from the well-fed and well-clothed Burmese. In the Southern Hemisphere, New Zealand, with its fertile soil and high mountains, securing a perennial supply of water, presented inhabitants that, of all wild races with whom the Europeans had come into contact, showed themselves the most courageous and spirited, although they had sprung from the effeminate people of the intertropical isles of the Pacific, a difference of character which could hardly have arisen from any

other cause than that of a comparatively rigorous climate necessitating exertion. On the vast continent of America, possessed of many of the essential properties requisite for a high civilization, the progress of civilization had been arrested by the insuperable barrier presented by its great forests to the feeble efforts of savages. But its greatest defect was in being peopled by a race below even the negro of Africa in intellect and physical strength. The physical deficiencies of Africa are impressed in the debased condition of its inhabitants. The early advance of the Egyptians was consonant with the peculiar fertility of their country, conferred by the floodings of the Nile, and so throughout every great region of the world examples were selected showing the coincidences of the conditions of races with the geographical conditions of their localities. The dominant superiority of the European races was strongly shown in our subjugation of India, and in the dictation of the Chinese Treaty by the Generals of a small English and French army to the lord of 400 millions of one of the most efficient of the Asiatic races. Of the effects of the physical geography of a country on a race, our own Wales and the Highlands of Scotland gave prominent examples, for it is certain that if our whole land had been in the like state we never could have become the great, prosperous, and opulent people we are. The paper created a considerable discussion, there being no less than thirteen speakers.

ETHNIC SIGNIFICANCE OF THE HUMAN SKULL.

Prof. D. Wilson, of Toronto, remarks:—From the various aspects which this craniological department of physical ethnology discloses to the inquirer, it becomes obvious that it is a considerably less simple element of classification than was assumed to be the case by Retzius, Morton, or any of the earlier investigators of national forms of the human skull. To the *brachycephalic* and *dolichocephalic* types of Retzius have now been added the *kumbecephalic*, the *platycephalic*, and the *acrocephalic;* and to the disturbing element of designed artificial compression, it is apparent we have also to add that of posthumous distortion as another source of change, affecting alike the mature adult, even when old age has solidified the calvarium into an osseous chamber, from which nearly every suture has disappeared, and the immature fœtus, in which adhesion of the plates of the skull has scarcely begun. When more general attention has been directed to this element of abnormal cranial development, additional illustrative examples will no doubt be observed by craniologists; and the circumstances under which they are found will help to throw further light on the peculiar combination of causes tending to produce such results.—*Edinburgh New Philosophical Journal.*

PHYSIOLOGICAL FUNCTIONS.

M. Flourens, the eminent physiologist, announces that he has repeated the whole of his former experiments upon the respective

independence of the Physiological Functions, and upon the special operation of each of the organs of the brain. He has confirmed anew this great fact, that no animal from which the brain is removed, leaving the cerebellum, loses suddenly and completely the use of its instinctive and intellectual functions, but retains the integrity of its functions of motion, which remain perfectly in harmony. On the contrary, when the cerebellum is removed, leaving the brain, the animal retains its intellectual functions, but becomes incapable of governing its motions. It is well known that the section of the internal semicircular canals of the ear produces abnormal movements of rotation, in which the animal throws a somersault from right to left, or from left to right, forwards or backwards, according to which of the canals has been cut. M. Flourens has well studied these mysterious phenomena, and has proved that there is a constant relation between the direction of the incised canal and the direction of the abnormal movement the incision determines. In this philosopher's *Natural Ontology; or, Philosophical Studyof Beings,* he strongly repudiates the philosophy of spontaneous generation.

VIVISECTION.

THE number and severity of philosophical experiments upon living animals has of late years so much increased in France and this country that the utility and defensibility of this mode of research are now greatly questioned throughout Europe, especially on the Continent. The Societies for the Protection of Animals in Paris and Dresden recently appointed a committee of eminent men to consider the subject. Their report admits the validity of many arguments showing the uselessness of Vivisection, but asserts that in some cases it is advantageous. We are informed that the eminent surgeon, Mr. G. Macilwain, has been requested by the London Society for the Prevention of Cruelty to Animals to give his views on the subject, which he has done in a pamphlet already printed, and which will probably be published by the society. He contends, in unison with Sir Charles Bell, (*Nervous System,* 1830, page 218), Longet, Owen, and others, that vivisection has not only been of no use, but that it has led to great errors both in reasoning and practice. The question has recently been much adverted to in the French journals, especially *Cosmos,* and merits consideration on both moral and scientific grounds.—*Illustrated London News.*

RESUSCITATION OF LIFE.

AT the late Meeting of the British Association, in the department of physiology, Dr. B. W. Richardson gave the results of his "Researches on Resuscitation." The modes of resuscitation he dwelt upon were—1, artificial respiration; 2, galvanism; 3, injection into blood-vessels; and 4, artificial circulation. Amongst the conclusions stated were these, that artificial respiration is useless if the heart's action has ceased; that the heart's action may be prolonged by

artificial respiration in a temperature of 130 degrees where it would cease at once at an ordinary temperature; that when the heart has ceased to act in these cases, the right side of the organ is full of blood and the left nearly empty; that then the column of blood which should pass from the right side to the left is broken, the hydrostatic law is violated, the two sides of the heart are in opposition, and the right side has not only to get over the weight of the column of blood, but also the contractile power of the left side—a thing it cannot do; that galvanism applied in any way to stimulate the heart hastens the cessation of the heart's motion; and that the great desideratum is some simple mechanical means of effecting artificial circulation. In cases of suspended animation, if any respiration, however feeble, exists, no attempt should be made to interfere with it; the patient should be placed in a dry atmosphere, at 130 degrees of heat. Electricity and galvanism are worse than useless; but injection of arterial blood into arteries might be useful in many cases, if such blood could be obtained.

Dr. Simpson, of Edinburgh, spoke in high terms of the value of Dr. Richardson's researches, and confirmed his view of the noxious effects of galvanism. Chloroform, Dr. Simpson mentioned, applied in cases of strychnine, will save life.

THIRST ON MONT BLANC.

GALIGNANI, in describing a recent ascent of Mont Blanc, says: Five German savans, and among them Professor Pitchner, when in the midst of the ice near the summit of Mont Blanc, did not suffer from the cold, having taken all necessary precautions to guarantee themselves against it; but they sustained great inconvenience from the atmosphere, and could not succeed in satisfying their thirst. They took with them abundance of provisions, but could not eat without pain, and only desired to drink. As a protection against the reverberation of the sun on the snow, they wore a covering over the face, but their features became so blistered that they could scarcely be recognised. According to the above accounts they would not be able to live long at the height at which they are without being subject to great changes, physical and moral. They took up with them some animals, which also suffered greatly; a cat was incapable of making any movement, and a dog for some days has ceased to bark. Some pigeons appeared to suffer less.

THEORY OF CONSUMPTION.

IN a late sitting of the Academy of Medicine at Paris, Dr. Piorry read a paper on the treatment of Phthisis, in which he developed the following propositions:—1. Pulmonary phthisis is a combination of multifarious variable phenomena, and not a morbid unity; 2. Hence there does not and cannot exist a specific medicine against it; 3. Therefore, neither iodine nor its tincture, neither chlorine, nor sea-salt, *nor tar can be* considered in the light of anti-phthisical reme-

dies; 4. There are no specifics against phthisis, but there are systems of treatment to be followed in order to conquer the pathological states which constitute the disorder; 5. In order to cure consumptive patients, the peculiar affections under which they labour must be studied and appreciated, and counteracted by appropriate means; 6. The tubercle cannot be cured by the use of any remedy, but good hygienic precautions may prevent its development; 7. The real way to relieve, cure, or prolong the life of consumptive patients is to treat their various pathological states, which ought to receive different names according to their nature; 8. Consumption thus treated has often been cured, and oftener still life has been considerably prolonged; 9. Phthisis should never be left to itself, but always treated as stated above; 10. The old methods founded on the general idea of a single illness called phthisis are neither scientific nor rational, &c.; 11. The exact and methodical diagnosis of the various pathological states which constitute the malady will dictate the most useful treatment for it.

THE HAIR SUDDENLY CHANGING COLOUR.

DR. J. DAVY has read to the British Association a paper "On the Question whether the Hair is or is not subject to Sudden Change in Colour." The popular notion is decidedly in favour of the affirmative, and many naturalists and physiologists have come to the same conclusion. They adduce instances of the change of the hair to white or grey, in the case of persons under strong emotions of grief or terror. Haller, in his *Elementa Physiologiæ* refers to eight authorities for examples of such changes; but all that he seems to admit for himself is, that, under the influence of impaired health, such a change may take place slowly. Marie Antoinette was cited by favourers of the popular notion as a striking and well-authenticated instance; but, when fairly considered, the case came under the condition admitted by Haller. Had it been possible for mental emotion, whether of terror or of grief, to render hair suddenly grey, surely in the Queen's case the change should have been witnessed at an earlier period than that of the arrest of the Royal Family in their attempt to leave France. If such a sudden change could be presumed, might we not expect to witness it in soldiers engaged in an active campaign amidst all the dangers and horrors of war? He had himself examined thousands of soldiers, men prematurely worn out in various climates, and concerned in many a hard-fought battle —many of them grievously wounded—but he never met with an instance of the kind. The case of a rebel Sepoy is stated by Dr. Laycock, in the April number of the *British and Foreign Medico-Chirurgical Review*, on the authority of Surgeon Parry; it being said that the man's hair changed from black to grey in half an hour. He was undoubtedly under the belief that he would be condemned to death. Might not this be the explanation? The man was hurried in, profusely perspiring; he was naked, and cooling and drying rapidly, his hair, previously grey, being darkened by moisture, resumed its natural colour.

The effect of water in intensifying colour is well known; and a further circumstance in aid of the explanation given may be found in the fact that the natives of Bengal are in the habit of staining their hair. The *Transactions* of the Royal Society, extending over two hundred years, do not contain an instance of such change in the colour of the hair; a circumstance opposed to the conclusion that it ever took place, for had it ever been undoubtedly witnessed, it is not likely that it would have remained undescribed. The author is not aware that, irrespective of recorded evidence, anything in support of the popular notion can be adduced on physiological grounds. Human hair cannot be injected. Using colouring fluids, such as a solution of nitrate of silver and a solution of iodine, the author has not observed any change of colour, except in the portions actually immersed. Whether it owes its colour to a fixed oil, to a peculiar arrangement of its constitutional molecules, or to both, it resists decay in a remarkable manner; it resists the action of acids and alkalies, except the strongest, which dissolve it. It resists maceration, and even boiling water, except continued for a long time, and under pressure, when it suffers disintegration and decomposition. Exposure to the sun will bleach hair, but this will not account for any very sudden change of colour. Supporters of the popular opinion refer to changes in the plumage of birds, such as the ptarmigan, and in the hair of certain quadrupeds, such as the mountain hare and ermine, which become white towards winter, and of a darker hue when the winter is passed. The belief is rested on, that this is not caused by moulting, or a change of coats, but that it takes place in the existing feathers and hair. But there is no satisfactory evidence of such changes; and considering the qualities of both, they seem most improbable. There is good proof that in the ptarmigan the change is decidedly connected with moulting; at least, such is the author's decided impression from inspecting the numerous specimens shot at different seasons, belonging to Mr. Gould—which eminent ornithologist says, that the "ptarmigan is always moulting;" the changes being from brown in the summer, to speckled in the autumn, and white in the winter. The speckled feathers, few and large, overlap the white; and as soon as those few are shed, the bird appears in its white dress. The similar change amongst quadrupeds most probably arises from the same cause; and examples, less striking than those amongst wild animals, can be observed in cases of the horse and the cow. Professor Rolleston, of Oxford, had given to the author a portion of the hair of a pony which had been observed to change its coat from tawny to nearly white in winter. Mr. Erasmus Wilson, who advocates the popular doctrine, refers to the case of a lemming in support of his views; but Mr. Blyth, a naturalist, says that he examined a lemming killed during its autumnal change, and satisfied himself that "the white hairs were all new, and not the brown changed in colour." There are reasons why it might be expected that the summer coat and plumage should be darker than those of the winter.

The author concludes that whether we consider one side of the question or the other—the human evidence so questionable, the physiological so much more reliable — the idea of fallacy is unavoidable, as to the hair being subject to sudden change of colour from mental impression. The attempts made to explain such a change by physiologists are allowed to be complete failures; and more amusing attempts had been made to explain the phenomenon on other grounds than those of fallacy. The author, when on foreign service, knew an assistant-surgeon of a regiment who had become insane, and whom he visited a fortnight or three weeks subsequently. The patient's hair, before brown, had become grey; but when he called attention to the fact, the regimental surgeon simply said, "Your surprise will cease when you know that —— has, since he has been afflicted with his malady, discontinued dyeing his hair." When we consider how prone the hair of some persons is to turn grey at an early age, even without accompanying or preceding bodily ailment, and how many would wish to conceal this blemish, and so have recourse to chemical means, it is easy to imagine that this source of error may not be unfrequent. Nor should it be overlooked that there is a disposition in some to make statements merely for the sake of exciting momentary surprise or of acquiring ephemeral notoriety. If we consult the records of imposition and delusion, we shall find many a thing attested, and for a time believed, of as marvellous a kind as the sudden whitening of the human hair. Has not witchcraft had its defenders? Have not table-turning, clairvoyance, and spirit-rapping had believers? Have there not been even physiologists who have given their credence to spontaneous combustion of the human body, and to equivocal generation?

ANIMAL LIFE IN SPITZBERGEN.

THE Scientific Expedition despatched by the Swedish Government to investigate the physical geography of Spitzbergen has returned to Trovuss. Besides correcting the charts and maps of this locality, which were very erroneous, many extremely interesting researches have been made. From these it appears that Animal Life is abundant in these glacial regions at the great depth of 1250 fathoms, and it has also been ascertained that the great Gulf Stream, which sweeps past the Norway coast, reaches as far as the coast of Spitzbergen.

ACCLIMATIZATION OF ANIMALS.

THE Society have made their first annual Report. The first meeting to form this society was held June 26, 1860. Since that time it has contributed in various ways to spread valuable information regarding acclimatization, and to promote the introduction and improvement of useful or ornamental animals in Great Britain and in foreign countries. Branch societies have been established in Glasgow and Melbourne, Australia. Lectures on this subject have been delivered before the British Association, and in the lecture-

hall of the Society of Arts. Several species of animals have been introduced into this country, such as quail from Canada, prairie grouse from the United States, diminutive sheep from Brittany. They have enlisted the co-operation of the Thames Angling Preservation Society, as regards pisciculture, and are assisting in establishing a fish-hatching apparatus at Sunbury, and in obtaining a supply of salmon. They have obtained specimens of the Chinese yam, the *dioscorea butatas*, the West Indian sweet potato, a new kind of edible bean from British Honduras, and from the White Nile specimens of elephant beans, red beans, and other very valuable varieties of beans and peas. Three objects are now before the society: First, introduction of a new animal. The most desirable of these appears to be a small species of sheep. There are small sheep to be obtained at Aden; in India (the *purik*); and from China. Several members have expressed great longing for importations of the eland; these beasts have already been acclimatized by the Earl of Breadalbane, Lord Hill, and by Lord Powerscourt. Secondly, the introduction of a new bird. They have a promise of eggs and young birds of the various North American grouse species from Captain Hardy, now resident at Nova Scotia, which will be sent over in the spring. They have also promises of guans and curassows, as farmyard birds, from the Hon. Chief Justice Temple, of British Honduras. They have also promises of various kinds of Indian game fowl from a gentleman (R. M. Brereton, Esq.) living in the jungles of Central India, and the promise of one of the council, Captain S. D. Damer, M.P., to procure grouse from Norway. Thirdly, a good new pond fish. Dr. Günther, of the British Museum, a gentleman whose extensive knowledge of fish has obtained for him a European fame as an ichthyologist, has highly recommended two fish, viz., the *siluris glanis*, which he has himself brought alive to England, and also the *guaramier*, *osphoremus olfax*, which is pronounced to be the very best fresh-water fish in the world. This fish is a native of Jamaica, but has been taken alive to the Mauritius.

THE GORILLA.

PROFESSOR OWEN has read to the British Association a paper "On some Objects of Natural History from the Collection of M. Du Chaillu," of which the following is a summary:—Professor Owen's first knowledge of the zoological collection was derived from a letter sent by M. Du Chaillu, dated Gaboon, June 13, 1859, and received in the British Museum in August, 1859, in which M. Du Chaillu specified the skins and skeletons of the Gorilla or n'gena, kooloo-kamba, nschiego, and nschiegombovie which he had collected, offering them for sale, with other varieties, to the British Museum. Professor Owen replied, recommending the transmission of the collection to London for inspection, with which recommendation M. Du Chaillu complied, bringing with him all the varieties he had named, with other objects of natural history, from which he permitted selection to be made. The skins of the adult male and female of the

young of the troglodytes gorilla afforded ample evidence of the true colouration of the species. In the male, the rufo-griseous hair extends over the scalp and nape, terminating in a point upon the back. The prevalent grey colour, produced by alternate fuscous and light grey annulations of each hair, extends over the back, the hair becoming longer upon the nates and upon the thighs. The dark fuscous colour gradually prevails as the hair extends down the leg to the ankle. The long hair of the arm and forearm presents the dark fuscous colour; the same tint extends from below the axilla downwards and forwards upon the abdomen, where the darker tint contrasts with the lighter grey upon the back. The scanty hair of the cheeks and chin is dark; the pigment of the naked skin of the face is black. The breast is almost naked, and the hair is worn short or partially rubbed off across the back, over the upper border of the iliac bones, in consequence, as it appears, of the habit ascribed by M. Du Chailiu to the great male gorilla of keeping at the foot of a tree, resting its back against the trunk. The skin of the great male gorilla, as mounted in the British Museum, exhibits two opposite wounds,—the smaller in front on the left side of the chest, the larger close to the lower part of the right blade-bone. Two of the ribs in the skeleton of this animal are broken on the right side near where the charge had passed through the skin in its course outwards. These marks correspond with the account of the slaughter of the great gorilla given by M. Du Chaillu.

Professor Owen proceeded to describe the colour of the female gorilla, which, it appears, was generally darker and of a more rufous tint than the male. In one female the rufous colour so prevailed as to induce M. Du Chaillu to note it as a red-rumped variety. In the young male gorilla, 2 feet 6 inches in height, 1 foot 7 inches in the length of the head and trunk, and 11 inches across the shoulder, the calvarium is covered with a well-dressed "skull-cap" of reddish-coloured hair. The back part of the head behind the ears, the temples and chin, are clothed with that mixture of fuscous brown and grey hair which cover with a varying depth of tint the trunk, arms, and thighs. The naked part of the skin of the face appears to have been black, or of a very dark leaden colour; a few scattered straight hairs, mostly black, represent the eyebrows. A narrow moustache borders the upper lip, the whole of the lower lip and sides of the head are covered with hair of the prevailing grey fuscous colour.

The rich series of skulls and skeletons brought home by M. Du Chaillu illustrate some most important phases of dentition. These phases were specified by Professor Owen at length. The deciduous or milk dentition, it was remarked, were in the youngest specimen of the gorilla something similar to those of the human child, but an interspace equal to half the breadth of the outer incisor divides that tooth from the canine, and the crown of the canine descends nearly two lines below that of the contiguous milk molar. The deciduous molars differed from those of the human child in the more pointed shape of the first, and much larger size of the second. The dentition

of the young gorilla corresponds best with that exemplified in the human child between the eighth and tenth years; the difference, however, is shown in the complete placing of the true molar, whilst the premolar series is incomplete. It was worthy of remark, also, that in both specimens examined the premolars of the upper jaw had preceded those of the lower jaw, and that the hind premolar has come into place before the front one. In the later development of the canines and the earlier development of the second molars of the second dentition the gorilla differs, like the chimpanzee and the orangs, from the human order of dental development and succession. An opportunity of observing this order in the lower races of mankind is rare. Professor Owen availed himself of the opportunity in the case of the male and female dwarf Earthmen from South Africa, exhibited in London. He found dentition at the phase indicative of the age of from seven to nine in the English child; other indications agreed with this evidence of immaturity. The children were dressed and exhibited as adults. Both showed the same precedency in development of canines and premolars which obtains in the whole race. Referring next to the variety of the chimpanzee brought by M. Du Chaillu from the Camma country and from near Cape Lopez, Professor Owen remarked that this species accords specifically in its osteological and hirsute development with the *Troglodytes niger*. It is stated by M. Du Chaillu to be distinguished by the natives of Camma as the nschiegombovie from the common chimpanzee (*Troglodytes niger*), called by them the nschiego. From the character of the skins of the male and female specimens of this species brought by M. Du Chaillu to London, Professor Owen would have deduced evidence of a distinct and well-defined variety of Troglodytes.

The reading of this paper was followed by a discussion in which Prof. Owen, Dr. Lankester, and M. Du Chaillu took part. Prof. Owen, on being requested to point out the principal distinctions between man and the gorilla, drew attention to the fact of its inability to stand on its hind legs, and the multitudinous points of adaptation in structure which such an incapacity demanded. He also went into the details of the anatomical structure of the brain in the monkey tribes, and insisted on the great differences of structure which that organ presented in man and the quadrumana. Independent of the great size of the brain in man, it possessed certain parts, as the hippocampus minor, which existed only in an undeveloped or rudimentary condition in the monkeys.

Dr. Wright, of Dublin, read the following communication from Dr. J. D. Gray, "On the Height of the Gorilla." Much difference occurs in the statements of travellers and others with reference to the height of the great African ape. Bowdich, the first traveller by whom it was mentioned, under the name of the *Ingēna*, states it, on the authority of the natives of the Gaboon, to be generally 5 feet high; but in some recent notices, it has been asserted to reach the height of 6 feet 2 inches; and the specimen exhibited at the meeting of German naturalists at Vienna is said, on good authority, to have

measured more than 6 feet in height. The measurement of a stuffed skin without bone is necessarily delusive, depending as it does, firstly, on the mode in which the skin has been originally prepared, and, secondly, on the extent to which the artist may be disposed to stretch it. Such measurements are not to be relied on unless they are in accordance with those of the bony skeleton; and it, therefore, occurred to me that it would be desirable to measure the long bones of the limbs of the different skeletons existing in the British Museum, the osseous structure giving the only certain dimensions on which reliance can be placed. The skeletons in the British Museums are six in number, viz.—1. A skeleton, obtained from Paris by Prof. Owen, and mounted in the best French manner; 2, 3, 4. Skeletons of male, female, and young, purchased from M. Du Chaillu; 5. A skeleton of a male, purchased at Bristol, of which we have also the stuffed skin; 6. An imperfect skeleton, purchased from M. Parzudaki, of Paris. The measurements of the several bones of each of these skeletons are given in the following table:—

	Humerus.	Ulna.	Radius.	Femur.	Tibia.	Fibula.
	Measurement in inches.					
Articulated Specimen from Paris	17	14	13	14½	11½	10½
Skeleton from Du Chaillu's stuffed specimen (called the "King of the Gorillas")	16¼	14	13¼	13¾	11	9¾
Skeleton of young male, from the specimen purchased at Bristol	14½		11	15		9½
Imperfect skeleton, purchased of M. Parzudaki	12	11	10	11		9¼
Skeleton of female, purchased of M. Du Chaillu	13	11	10½	11	9	7
Skeleton of young male, purchased of M. Du Chaillu	12	11½	9¼	10	8½	7

They were taken by Mr. Gerard with a tape measuring inches and quarters of inches only, but are quite sufficient for a comparison betwen the specimens themselves, and as affording materials for determining the actual height of the animal. As the largest of these (viz., the Paris specimen, photographed for the Trustees of the British Museum by Mr. Fenton) stands 5 feet 2 inches in height, we are justified in concluding that to be in all probability the extreme natural height of the full-grown animal.

The preceding statements of Prof. Owen's about the Gorilla recently acquired for the British Museum, led to a reply from Dr. Gray, impugning their accuracy: it was read in the Section of Zoology, and produced a considerable sensation. Prof. Owen had left Manchester, but on receiving a copy of Dr. Gray's communication, he wrote an explanation to the President of the Section, which explanation arrived too late: we give, first, Dr. Gray's letter:—

Dr. Gray to Professor Babington.

British Museum, Sept. 6, 1861.

My dear Professor,—It is with much regret that I feel myself called upon to *correct an error* which appears in the report of Professor Owen's Paper on the

Gorilla, &c., contained in the *Times* of this day. Professor Owen is there represented as stating, that "the skin of the great male gorilla, now in the British Museum, exhibits two opposite wounds, the smaller in front of the left side of the chest, the larger close to the lower part of the right blade-bone. Two of the ribs in the skeleton of this animal are broken on the right side, near where the charge has passed through the skin in its course outwards." As this would appear to offer a direct contradiction to a statement made by myself, I cannot (although labouring at present under a severe attack of illness, and writing from a sick chamber) pass it over in silence.

My attention was called to the subject by Mr. Joseph Beck, the well-known microscopist, who first made the observation that none of the skins of the gorilla exhibited by M. Du Chaillu offered any evidence of having been shot in the fore part of the chest, as invariably stated in his *Narrative*. My own examination entirely confirmed this remark; and the unanimous conclusion of numerous sportsmen and men of science, who have since examined both skins and skeletons, has been to the same effect.

The skin and skeleton referred to in Professor Owen's paper, are both, as stated, in the British Museum. While the skin was being stuffed at the Crystal Palace by Mr. Wilson, I paid a visit to that establishment, in the company of Mr. Grove, the Secretary, and several friends. I then inquired of Mr. Wilson whether he had observed any bullet-hole in the chest, and he stated that he had not, but pointed out to me two holes in the nape of the neck (now filled with putty); there are also two large holes in the thin portion of the hinder part of the skull belonging to the same skin which pass through the bone, and are quite sufficient to have caused death. In neither skin nor skeleton is there any evidence of a gunshot entering on the left side of the chest; and the fracture of three (not of two) ribs on the right side beneath the scapula, and the supposed corresponding rent in the skin, are so utterly unlike the effects of a gunshot, that no sportsman could possibly so consider them. These are facts so easily verified, that I trust all who feel an interest in the subject will examine and decide for themselves. I might cite many names of high authority in corroboration of what I have here advanced, but I am not disposed to appeal to any authority, however great, where the facts are open to the inspection of all. On these, and these only, I rest my case.

John Edw. Gray.

Professor Owen to the President of Section D.

Sheffield, Sept. 11th, 1861.

Sir,—Having just received the *Manchester Examiner* of the 10th inst. containing the letter from Dr. Gray on the death-wound of the large gorilla, I lose no time in making that reply which I should have submitted to the Section, had I been present when it was read. To the remark, that "the fracture of the ribs, and the supposed corresponding rent in the skin, are so utterly unlike the effects of a gunshot, that no sportsman could possibly so consider them," I answer, that the hole or rent in question is conspicuous: and that a gentleman who combines an acuteness of observation which has placed him high in science, with a well-known reputation as a skilful marksman and deerstalker—Sir Philip Grey Egerton—concurs with me in the opinion that the hole or rent in question does present the characters of the one by which the ball escapes in an animal so killed. The wound by which the ball penetrates is much smaller; for the living skin contracts, and the difference of size in the opposite wounds plainly indicates the course of the bullet. As to the ribs, their intervals are wider in the front than at the back of the chest: a ball might enter in front without impinging on the rib or its cartilage, and it would be between the eighth and ninth cartilage, or below the latter, according to the state of the breathing of the gorilla at the time, where the ball entèred in its way obliquely upward and to the right, according to my observation of the contracted aperture, distinctly manifested in the skin before it was sent to be stuffed. At the back of the chest, the ribs, where they bend outward and forward, are so close together as almost to overlap; a ball would most probably impinge on the contiguous parts of two, and a slight glancing movement, common in gunshots, might affect a third contiguous rib. No one can look at the back part of the thorax of the gorilla without seeing there the conditions under which such fracture as the right ribs exhibit, from within outwards, might take place, as the effect of a gunshot wound through the chest. As I, and all

who have had the pleasure of accompanying Sir P. Egerton in the deer-forest, must hold him to be a sportsman, the asseveration, therefore, that "no sportsman could possibly consider the fracture of the ribs and corresponding rent in the skin, as the effect of gunshot," must pass into the category of many other assertions aimed at the character and reputation of M. Du Chaillu. The holes in the skin of the neck were mere slits made by the knife, after the death of the gorilla, probably in the act of flaying, and removing the skin from the long projecting cervical spines; those holes showed no mark of contraction of living skin, like the wound in front of the chest.

RICHARD OWEN.

In the subsequent week Dr. Gray communicated to the *Athenæum* the following supplementary note:—

British Museum, Sept. 21, 1861.

May I request that you will lay before your readers the accompanying engraving, from a photograph, of the bones of the trunk of the "King of the Gorillas," with the articulating wires, and, also, of the posterior region of the skull of the same skeleton, exactly in the condition in which they were sent to the British Museum by M. Du Chaillu. The photograph shows the holes in the back of the skull, which Prof. Owen, in answer to an observation made by Dr. Sclater at the Manchester Meeting, stated that he had not observed; together with the true position of the fractures of the ribs. I repeat my invitation to all who take an interest in the subject to inspect the specimens, and determine for themselves; but, for the sake of those who are unable to visit the Museum, I offer a photographic representation, as the next best corroboration of the correctness of my statements. It will at once be seen that the fractures of the seventh, eighth, and ninth ribs on the right side are not situated "at the back part of the chest, where the ribs bend outward and forward, and are so close together as almost to overlap," but are very greatly in front of the position indicated, being as nearly as possible in the middle of the side, where the ribs stand widely apart, and where it is impossible that any bullet, entering the chest in front, could have found its exit. Neither is there the slightest indication of the fractures having taken place "from within outwards"; on the contrary, it is the unanimous opinion of the medical and scientific men to whom I have shown the skeleton that the injury to the ribs was caused by external violence; and this is rendered the more probable by the existence of a fracture of the collar-bone on the same side.

The lateral position of these fractures at once disposes of all Prof. Owen's arguments as to the mode in which a bullet might enter "in front" of the left side of the chest, without injury to the ribs of that side, and pass out on the other side, breaking three ribs in its exit. It is, also, very significative that Mr. Bartlett and Mr. Wilson, the artists by whom the skin was stuffed, should not have observed any bullet-holes in the chest while the skin was damp and soft, and that they should have noticed the holes in the nape of the neck, and considered them as bullet-holes. Certainly, no taxidermist with any experience could fail to perceive the difference between a bullet-hole made during life, which forces the edges of the wound aside, and a "slit made by the knife after death—in the act of flaying."

J. E. GRAY.

To this M. Du Chaillu replied in the *Times*, appealing to his friends in the Gaboon for corroborative evidence of the authenticity of his travels, scientific discoveries, and trading operations.

This produced a letter from Mr. R. B. Walker, long a resident in the Gaboon country, impugning the accuracy of M. Du Chaillu's statements. This letter the *Times* refused to insert, but it appeared in the *Morning Advertiser*. Thereupon, Mr. Walker was attacked by an anonymous correspondent in the *Times*, replied to by Mr. Simmonds, brother-in-law of Mr. Walker, and proving his respectability and scientific competency to judge of the matter, but allowing a discrepancy in Mr. Walker's opinions of M. Du Chaillu then, and *three years* previously.

Here we must leave the matter: the assertions and counter-assertions would occupy far more space than we can devote to the subject. It has afforded amusement in various shapes—in the chapels and theatres—but we hope the real value of M. Du Chaillu's statements will not, in the *mêlée*, be lost sight of.

We must, however, notice a letter signed J. B. Doyle, Sandymount, Dublin, in which the writer shows that the gorilla was known even by name to the ancients, more than 500 years before the Christian era. This is shown by quotation from Falconer's Greek text of the *Periplus* of *Hanno*, the Carthaginian navigator, with a literal translation. Hanno distinctly says that he saw at a bay, called the Southern Horn, certain savage people, mostly women, whose bodies were hairy, three of whom were taken, killed, and flayed, and their skins brought to Carthage. Mr. Dóyle concludes as follows: That these gorillas were not a race of "hairy men," but some large and powerful species of ape, we have abundant proof in the comments of the ancient authorities quoted by Falconer; and, considering the proximity to the modern country of the gorillas and the similarity of climate, it is not unreasonable to conjecture that the creatures whose skins Hanno brought back to Carthage were not only in name but in reality the same species as those which now form such an attraction in the British Museum.

THE BRAIN OF A YOUNG CHIMPANZEE

HAS been described by Mr. John Marshall, of University College, London, in the *Natural History Review*, illustrated by plates and a photograph. The weight of the entire animal was 16 lb. 8 oz. avoirdupois: the brain immediately after its removal from the cranium weighed 15 oz. Deducting the weight of the membranes, and allowing for the blood, &c., Mr. Marshall gives its absolute weight at 14 oz., which is, he says, the heaviest ape-brain yet on record; the brain of the young orang described by Dr. Rolleston being 12 oz., and the absolute weights of the half-grown male and of a female chimpanzee described by Professor Owen being 9¾ oz. and 13¼ oz. respectively. This brain is, however, light in comparison with the human brain in a child at a corresponding period of dentition, which would average at least 38 oz. After a careful description of the various parts, and comparison with the descriptions of Vrolik, Gratiolet, and others, Mr. Marshall states that he found all the parts of the cerebellum the same as in the human brain, only the lateral hemispheres are wider and flatter, and adds that he merely records the results of an anatomical investigation, and that he has no theory to support, or any leaning towards any of the developmental hypotheses on the origin of species.

RABBIT-BREEDING IN FRANCE.

THE *Aigle du Midi* states that a farmer named Pinel, of Revel, in the department of the Haute-Garonne, has commenced Breeding

Rabbits on an extensive scale for consumption, and that he expects the operation to be successful in a commercial point of view. In the space of five months, from May last, he, with 50 female and five male rabbits, obtained 1300 young, and he now intends to have 200 females. By allowing these latter to produce only every two months instead of every month, as they can do, he calculates that he can procure 500 rabbits a month, or 6000 a year. He has had constructed a large shed, 30 mètres long by 20 wide, and 40 feet high, and in it are 140 compartments, of which 10 are set apart for young rabbits separated from the dams, 14 for the adults, 12 for the males, and the rest for doe rabbits and other purposes. Pinel makes this calculation :—Out of 270 rabbits born every month the average number of deaths is 12, so that there remain for sale 258, which can be disposed of for 1f. 10c. each, making 283f. 80c. or 3405f. 60c. a year. This sum is increased to 4653f. 60c. by the sale of the manure. As rabbits can be fed in great part on the refuse of the farm-house and farm-yard, it is thought that peasants might, like Pinel, breed them with advantage.

THE RED-RIVER HOG.

The Zoological Society's Illustrated Proceedings contain a most characteristic picture, by Mr. J. Wolf, of the Red-River Hog of West Africa and its four young ones. These latter were born in October, 1859. The efforts of the keepers to preserve them were quite unavailing, and they disappeared one by one, having been destroyed by their mother within a few weeks after their birth. The striped condition of the immature animal is found in the young of the wild hog of Europe and of India, but not in any corresponding stage of the young of the domesticated animal in this country, as far as we are aware. The male Red-River hog died in February, 1860, and the female in the following November. Dr. T. Spencer Cobbold gives in the same number of these *Proceedings*, some notes on the remarkable entozoa from these animals and the wart hog.

ANTELOPES.

The Zoological Society have erected in their gardens in the Regent's Park a new Antelope House, at a cost of about 2500*l.*

A collection of animals received a short time ago from the Cape of Good Hope, presented to the Society by his Excellency Sir George Grey, the Governor of the colony, and brought safely home under the care of Mr. James Benstead, the society's agent and collector, contains several remarkable additions to the beautiful family of Antelopes, to the accommodation of which this building is proposed to be exclusively devoted. The series of these animals living in the Society's gardens in August last, embraces no less than fifteen species. The following is a list of them :—

1. *The Dorcas* Gazelle (*Gazella dorcas*), from Egypt and Northern

Africa generally. Several fine examples of this beautiful species have been lately received.

2. The Spring-bok (*Gazella euchore*) of Southern Africa.

3. The Stein-bok (*Calotragus tragulus*), lately received, for the first time alive in Europe.

4. The Grys-bok (*Calotragus melanotis*), also just received from Southern Africa, but previously in the late Earl of Derby's collection at Knowsley.

5. The Grimm's Duyker-bok (*Caphalolophus Grimmi*), from South Africa.

6. The Maxwell's Duyker-bok (*C. Maxwellii*), from Western Africa.

7. The Reh-bok (*Heleotragus capreolus*). Female.

8. The Lechè Antelope (*Adenota lechè*). Of this beautiful species of Antelope, which was first discovered by Captain Frank Vardon in one of the earlier expeditions to Lake Ngami, the collection contains a single female, remarkable for its tame and quiet disposition.

9. The Leucoryx (*Oryx leucoryx*). The Leucoryx, which was first introduced into England by the late Earl of Derby, breeds freely in confinement.

10. The Addax (*Addax naso-maculatus*), a male, lately presented.

11. The Common Gnu (*Catoblepas gnu*).

12. The Brindled Gnu (*C. gorgon*). A pair of Gnus, composed of one of each of the two only known species of this curious form of antelope.

13. The Bless-bok (*Damalis albifrons*), a single example of this brightly marked antelope, believed to be the first ever brought alive to this country.

14. The Eland (*Oreas canna*). The herd of elands, originating from those bequeathed to the society by the late Lord Derby, at present consists of a male and four females. A steady increase takes place every year in their numbers, the spare animals being draughted off to supply the wants of sister societies and such noblemen and gentlemen as are desirous of assisting in the attempt to introduce this valuable animal into our parks and forests.

15. The Nylghaie (*Portax pictus*). This fine Indian antelope breeds readily in this country.

THE MOLE.

PROFESSOR OWEN has read to the British Association, a paper "On the Cervical and Lumbar Vertebræ of the Mole." The result of the Professor's contribution is as follows:—

In conclusion, he stated respecting the mole, that its loins were strengthened by super-additions to their vertebræ, precisely like those discovered by Sir Philip Egerton in the cervical vertebræ of the Ichthyosaurus—viz., by a series of "subvertebral wedge-bones" *infixed into the inferior* interspace between each of the six lumbar

vertebræ, as well as between the first lumbar and last dorsal, and between the last lumbar and the first sacral. These, which Professor Owen had determined to be "autogenous hypapophyses," have their broad, rhomboidal, smooth and slightly convex base downwards; and their narrower end wedged upwards into the lower part of the intervertebral substance. It is obvious that the lumbar region, co-operating with the pelvis, as the fulcrum during the vigorous actions of the hind feet, by which the loose earth is kicked out of the burrow, must derive an advantage from this super-addition to their fixation, analogous to that which the Ichthyosaurus derived from the wedge-bones of its cervical vertebræ. The lumbar hypapophyses of the mole had not escaped the notice of the sharp-sighted Jacobs, who speaks of them as "ossicula sesamoidea" (*loc. cit.* p. 17); but he deduces no physiological consequence from the fact; and this passing notice had not been recognised by any subsequent writer on the osteology of the Insectivora. From no systematic work or monograph on Comparative Anatomy, indeed, could the student acquire any hint of so curious a fact that the vertebral column of the mole combined two peculiarities which are separately given, in the Reptilian class—viz., to the Crocodilia and the Enaliosauria respectively. This paper was illustrated by diagrams of the structures described.

A PLEA FOR SMALL BIRDS.

M. BONJEAN has presented to the French Senate a Report on four petitions praying that measures might be taken to preserve Birds which destroy Insects hurtful to agriculture. The Report, which occupies five columns of the *Moniteur*, is an amusing essay upon insect-eating birds, their habits, anatomy, and species of food. It treats at length of the ravages of insects, and the importance to man of the objects they destroy. France is infested with thousands of species of insects of terrible fruitfulness, nearly all of which prey on what should serve the purposes of man. The first section of the Report is headed "Importance of Birds to Agriculture." It states that the wire-worm consumed 160,000*l.* worth of corn in one department alone, and was the cause of the three deficient harvests which preceded 1856. Out of 504 grains of colza gathered at hazard at Versailles, all but 296 had been rendered worthless by insects. The reduction of yield in oil was 32·8 per cent. In Germany, according to Latreille, the phalæna monacha consumed whole forests. In Eastern Prussia, three years ago, more than 24,000,000 cubic mètres of fir had to be cut down because the trees were attacked by insects. Man is unable to cope with these destroyers of the produce of his labour. His eye is too dull to perceive and his hand too slow to catch them. Without the aid of birds he would be vanquished in the struggle. The Commission excludes birds of prey, such as magpies, ravens, &c., with the exception of buzzards and rooks, from the benefit of its protection, because the buzzard consumes about 6000 mice yearly, and the rook an incalculable amount of

white worms. Sparrows are rehabilitated, and their usefulness shown by reference to the facts that when their destruction was attempted in Hungary, winged insects increased so rapidly that rewards for the destruction of sparrows were suppressed, and given for bringing them back. Frederick the Great ordered the destruction of sparrows because they ate his cherries; but in two years' time he found his cherries and all other fruits consumed by caterpillars. In a sparrow's nest on a terrace in the Rue Vivienne were found the remains of 700 cockchafers. Owls, and birds of that class, which agricultural ignorance pursues as birds of evil omen, ought to be welcomed. They are ten times more useful than the best cats, and not dangerous to the larder. The martens that were killed were found to have in their stomachs the remains of 548 insects. After further illustrations of the same nature, the Report proposes the prohibition of all means of destroying birds save by firearms, with the exception of nets for wild ducks and palmipedes generally, and the prohibition of bird-nesting and destruction of eggs or young birds. The petitions were referred to the Minister of Commerce and Public Works.

A Correspondent of the *Times* observes upon this subject that the remarks in relation to small birds apply with equal force to the larger birds of prey, and to weasels, polecats, and other small animals of that kind. He adds:—

I live in a district where game-preserving is carried to excess, and the numerous gamekeepers emulate each other in exhibitions of such birds and animals nailed upon their cottage walls. The result is that rats flourish. The keepers do not try to destroy them, for they are not sufficiently distinguished in their estimation to occupy a place in their cottage museums. Therefore rats swarm to an extent almost incredible, and they occupy the banks and hedges of fields far away from dwellings and farms in full force. I know farms where there is hardly a bank in a hundred acres but is mined by the rats until it is like a honeycomb. The farmers are compelled to keep ratcatchers continually at work in the fields, but without success, such is the difficulty of catching them in banks and among the long grass of hedges and ditches. The destruction of produce of all kinds is enormous, and is becoming a very serious matter. The game preservers appear ignorant of the numbers of eggs and newly-hatched young of partridges and pheasants and newly-born leverets destroyed by these vermin. Let them inquire, and they will think it worth while to restore the balance between the rats and their natural but deadly enemies, the stoat or weasel, the polecat, and other animals of that kind, and the hawks and owls, not only for the better protection of the game, but for the protection of the crops of their hardworking and industrious tenants.

Another Correspondent says, it has been obvious to all who have had the opportunity and the capacity to observe, that during the last few years the small birds have decreased considerably. In a like ratio, insects of the most destructive kinds have increased. In various parts of Kent, whole crops of fruit, vegetables, and grain have been swept off entirely by various kinds of minute insects, which the birds alone are competent to detect and destroy, and which not one man in a hundred knows anything about. In no localities have insects done so much injury to the fruit as where "sparrow clubs" are established, and where birds are indiscriminately and systematically exterminated. For example, at a village in Kent, prizes are given for the heads of sparrows, titmice, and other birds which feed almost exclusively on insects and their *larvæ*. The gardens in that locality are very extensive, and are planted chiefly with plum-trees. In 1858 they promised an extra-abundant crop, but long before the fruit was matured the larvæ of the winter moth, upon which the birds, especially the titmouse, feed, consumed almost the entire crop. The birds had been destroyed.

NEW PARROT.

Mr. Gould has pointed out to the Zoological Society the character of a New Parrot from Western Australia, referring it for the present to the genus Pezoporus with the specific name occidentalis, but suggesting that it would ultimately require generic separation from that type.

ON FISHES.

Prof. Owen has delivered at the Royal Institution a series of lectures on Fishes, from which we quote these details of cartilaginous fishes:—

The ancient *Squaloraia*, a fossil compound, as it were, of the shark and ray, was specially described. Its remains, found near Bristol, were at first considered to be those of a reptile, till their piscine character was determined by Agassiz. The structures of the rays and skates were next dwelt on; especially that of the torpedo, which has the power of converting its nervous force into electric force, and thus giving a shock like that of a voltaic battery. The last order described was the Holocephali, a genus of which was named by Linnæus *Chimæra monstrosa*, from its extraordinary appearance and structure. This fish (nearly extinct) is now found in the North seas, where it is called the king of the herrings and the sea monster, and also in the Australian seas.

In the Lecture devoted to the Fossil Ganoid Fishes, the Professor specially described the placo-ganoids, which abound in the Devonian or old red sandstone formation. Specimens of the genus of these were discovered by the lamented Hugh Miller, and submitted by him in 1840 to Professor Agassiz, who named it pterichthys (winged fish). It is a fair specimen of the family, having the head and the fore part of the body defended by ganoid plates—*i.e.*, plates composed of hard bone coated with enamel; those of the trunk forming a buckler composed of a backplate and breastplate articulated together; the armour of the head, or helmet, being articulated with a moveable joint to the buckler. The remains of another genus, the Coccasteus, having a helmet and cuirass firmly united, were compared to the probable state of the body of a French dragoon buried on the banks of the Borodino—a skeleton defended by armour. Another genus, the Siluroids, is represented at the present time by the Pimelodi of the Ganges, a little strongly-helmed fish with a naked body. To the decomposing remains of successive generations of these fishes, the Devonian flagstones of Caithness owe their density, tenacity, and durability, a large part of the county, before its upheaval, having formed the bed of a *piscina mirabilis* (marvellous fish-pond).

Messrs. Ffennell and Eden, the Government inspectors of Salmon Fisheries, have completed their official inspection of the upper portion of the river Severn and its tributary, the Verniew, and in a report made thereupon, call attention to the very valuable character of those waters, and the great advantage that would accrue by their

proper preservation, both to the proprietors of fisheries on the Severn, and the public generally. "No water (they write) could be found by its natural character better suited for the production of salmon; deep rocky pools, affording shelter and security to the fish, alternate with gravelly fords of the best description for spawning purposes. The water is unpolluted by mines or manufactures, and such weirs as now bar the passage of the fish can, and we hope will, be soon altered and cease to be obstructions. The evidence that was given us proves that poaching has been carried on to a most disastrous extent. Salmon have become so scarce in the higher parts of the river that they are seldom looked for. Nearly all the proprietors have ceased to use nets, for there are not fish enough now, we are told, to make it worth while to keep nets and boats. Even the poachers have directed their efforts against the trout, which have consequently, in their turn, decreased much both in size and number. No care whatever seems to have been taken of the fisheries; the net and spear are used all the year round." The inspectors, however, speak of the awakened interest that has been excited in the matter.

NEW FISHING-GROUND.

CAPT. RHODES, of the *Resolution*, and Capt. Gardner, of the *Adventure*, in July last, visited Rockall, in the North Atlantic Ocean, 136 miles from St. Kilda, the nearest land, and returned in eleven days, the one having caught nearly 15 tons, the other 12 tons, of the largest codfish ever seen, many of them weighing when caught 1 cwt., thus having each caught above 100*l*.-worth of cod in five days' fishing.

Captain Rhodes states that they caught the fish as fast as they could bait and haul, and when any of the cod escaped from the hook, monstrous sharks darted round the ship's side, and swallowed them in an instant.

The livers of the cod, he states, were also very rich, and produced large quantities of oil. The cod are very large and very thick; the tusks are very thick and fat, but shorter than usual, while the ling are the same as those caught at other places.

Captains Rhodes and Gardner, in their second visit to Rockall, each caught between thirteen and fourteen tons of cod-fish in about six days' fishing. These accounts were corroborated by the captains of two smacks from Grimsby, each of which caught about fourteen tons of cod, tusk, and ling in five days, about 100*l*. in value, and no bait required; any offal does for bait. One also captured a young shark there; its liver was four feet long, and gave three buckets of oil. They tell of encounters with great sharks thirty feet long, with mouths that could swallow calves, and bodies as large and round as tuns; of numberless large whales sporting and rising on every side of them. They also saw numbers of strange fish which they had never seen before, and some black fish larger than porpoises, with flat round heads, and which seemed very numerous.

Dr. Dawson, of Westray, in a letter to the *Times*, dated Oct. 18, has minutely described this new fishery, which will in the next season, doubtless, be resorted to by a great number of vessels.

PEARL-FISHERIES IN THE RIVER TEITH.

In summer, at ebb, in this Scottish river, Pearl-Fishing can be plied with success, as it is a manual operation. Along almost the whole course of the river there is a great abundance of the pearl shells. They are found thickly studded in certain parts of the river-bed among the gravel, the shells lying generally on their edge, and at various stages of its growth. The largest are about two inches in length and an inch and a half in breadth. Although there is an abundance of shells, the pearls are by no means numerous, and a great number of shells may be opened without finding any. Last summer, when the river was shallower than it had been for many years, an immense number of shells were opened, and a large number of pearls, some of considerable value, were found. After removing the coating, which forms the bedding of the inmate of the shell, the inside of the shell presents a beautiful pearl colour. It is at the animal's head the pearl, if there is any, is found. The outside of the shell has a rough grayish colour. The pearls themselves are of various sizes, and are not always white. Some of them are of a dark red colour. It is supposed that they are all originally of this colour, and undergo a gradual change in the shell until they become pure white. Most of them are small, and range from the size of a pea to that of the head of a pin. They are not all quite round; some are quite irregular in shape. The value depends upon the pure whiteness of the pearl, and it is no unusual thing to find one worth several pounds. Several derive their livelihood from seeking pearls and selling them to the jewellers. Children go in search of them; and sometimes have got as many as thirty to forty each during the season.—*Abridged from the Scotsman.*

DREDGING.

In the course of the discussion which followed the reading of the Reports of the Dredging Committees to the British Association, at their late meeting, Mr. Jeffreys stated that the several results of the labours of the dredging committees confirmed Edward Forbes's law, that the species which had the greatest vertical depth had the greatest horizontal range. At the same time, the law was not absolute, as the changes which had taken place in the elevation and depression of the sea-bottom since the last geological epoch had undoubtedly produced many local disturbances in the distribution of both plants and animals. He pointed out, however, the necessity of an accurate investigation of forms in order to determine their distribution. The Rev. Mr. Hincks observed, with regard to the record of the existence of *Coryne pusilla*, that it was very desirable that the particular variety should be stated. He knew many

varieties of this form of polyp, but knew of no book or paper where they were all recorded. Mr. Patterson announced that Professor Wyville Thompson, during his dredging this summer off the Shetland Islands, had procured five perfect specimens of the *Cidaris papillosa*. Of this fine sea-urchin, known as the piper, only the spines had been taken by previous naturalists.

THE AQUARIUM.

THE *Journal des Débats* has published an article on the Aquarium of the Jardin d'Acclimatation, by its constructor, M. Alford Lloyd, who declares this aquarium to be the largest ever constructed, being forty mètres in length and ten in breadth. The compartments have received a northern exposure, to avoid the inconvenience of having the temperature of the water too much heated by the rays of the sun; and for the same reason no windows have been pierced through the southern wall, so that the aquatic animals enjoy all the desirable coolness, while the spectator has the advantage of a subdued light necessary for distinct vision. The quantity of sea-water employed in the ten compartments reserved for marine animals is about 22,700 litres; and this water is never changed; it is only made to circulate incessantly in the compartments by means of a pressure obtained in the following manner:—A current of water obtained from the supply of the Bois de Boulogne is made to compress a certain volume of air, which in its turn exercises a pressure on the sea-water contained in a close pipe situated below the level of the aquarium; by this pressure the sea-water is made to rise, and to enter, charged with air, into the compartments, while an equal quantity of water flows off through a waste-pipe, whence it passes to a filter, and then to a subterranean reservoir, whence it returns to the compartments as above described. Besides this method of providing the inmates of the aquarium with the oxygen necessary to maintain life, another is employed, viz., the vegetation of plants, which, while they absorb the carbonic acid produced by respiration, emit oxygen at the same time. There is also a contrivance in the aquarium for raising or lowering the water in the compartments, so that an artificial ebb and flow may be produced. The diminution of the sea-water caused by evaporation is remedied by the addition of river water, which is sufficient, as the saline ingredients do not evaporate. Mr. Lloyd advises the public not to feel disappointed at the absence of large fish or crustacea in the aquarium, since such creatures would require a compartment to themselves, to prevent their committing havoc among their smaller companions. Again, the inmates of the aquarium must not be frequently changed, the object being precisely to have the same individuals before our eyes in order to study their habits. Lastly, the aquarium, like everything else, requires time in order to arrive at perfection, since vegetation is necessary, but is not and cannot be ready at command.—*Times.*

CAN SERPENTS POISON EACH OTHER?

M. GUYON has read to the Paris Academy of Sciences a paper upon this much-vexed question. In 1834, he had directed his attention to this subject, and then adopted the opinion of M. l'Abbe Fontana, who had previously stated that the venom of vipers was not mortal to vipers. M. Guyon resumed his researches in 1850, and has continued them to the present time. He has ascertained by experiments that the venom of vipers introduced by inoculation into other vipers does not cause death. When vipers bite other vipers or themselves they leave, not festering, but common wounds. The same is the case with serpents, whether they belong to the same or to different species. Those travellers who have related anything to the contrary have either been mistaken, or have exaggerated, or told myths. It is now an established fact that the venom of vipers is not venom to themselves. This is the reason why venomous reptiles are so numerous in some parts of the globe, as they are not naturally prolific. They cannot poison each other.

THE TOAD.

DR. DAVY has communicated to the Royal Society of Edinburgh a paper "On the Acrid Fluid of the Toad" (*Bufo vulgaris*). The author first adverts to the conflicting opinions respecting the nature of this fluid, and especially to one of the latest, that entertained by MM. Gratiolet and S. Cloez, that it is an active poison.

He next describes some experiments he has made for the purpose of testing their conclusion, the results of which are in opposition to theirs, and confirmatory of certain ones of his own, showing that the fluid is a simple acrid irritant, and as such well adapted to protect an animal otherwise defenceless, and, from its sluggish habits, peculiarly exposed to danger.

Incidentally, he makes some remarks on the Toad of Barbadoes, which, brought from Dominica only a few years ago, has so multiplied as to abound in every part of the island. Its comparative rareness in Britain he attributes to two causes: one, the circumstance of the very young toad being, as he believes, destitute of the acrid fluid; another, the intolerance of the toad of all ages of severe cold, and in consequence, its liability to perish if the winter temperature be unusually low.

In a foot-note, he expresses the opinion, founded on one observation, that the female toad during the breeding season is without the protecting acrid fluid, the male at that time having it in more than ordinary abundance, and, from position, whilst the ova are *in transitu*, probably defending his mate.

NEW COCCUS.

A NEW scarlet dye of great richness is attracting considerable attention in Canada. It is prepared from an nsect, a species of *Coccus,* found for the first time in the summer of 1860 on a tree of the common black spruce, in the neighbourhood of Kingston. This new dye closely resembles true cochineal, a most expensive colouring

matter, capable of being produced in warm countries only, and which is used to give a fine and permanent dye in red, crimson, and scarlet, to wool and silk. Unlike cochineal, the new dye discovered at Kingston is a native Canadian product, and capable of being produced in temperate countries. Having been but recently observed, a sufficient quantity has not yet been obtained to make a complete series of experiments as to its nature and uses; but the habits of the insect, as well as the properties of the dye, seem to indicate that it may become of great practical importance. In colour it closely resembles ordinary cochineal, having rather more the scarlet hue of the flowers of the *Adonis Autumnalis*, and no doubt other shades will be obtained. The true Mexican cochineal is now being cultivated in Teneriffe and other wine-growing countries of Europe and Africa, with such success as to displace the culture of the grape-vine; yet the directors of the East India Company in vain offered a reward of 2000*l.* to anyone who would first successfully introduce its culture into India.

THE SILKWORM.

It is expected that the silk trade in France will be considerably improved by a New Silkworm introduced some time since by M. Guerin Meneville. This silkworm lives in the open air on a very hardy plant called the "ailante," or Japan varnish tree. It produces two crops a year of a strong silky fibre employed in China to make clothes for a great portion of the population. The new silkworms have been reared in various parts of the south of France with perfect success. More than three-fourths of the worms produce excellent cocoons, although the atmosphere was unfavourable. It is now ascertained that the new worm gives a profit of cent. for cent. on the capital employed. The silk of the ailante worm differs essentially from that of the mulberry worm. It is of an inferior quality, well adapted for coarse fabrics, but it never can compete with the silk used by the manufacturers of Lyons. It is expected that the new silk will form an excellent substitute for cotton, of which France annually imports 69,504,000 kilogrammes.

M. Coupier, Sous-Prefêt du Vigau, announces that he is in possession of a specific against the silkworm disease. He has taken healthy worms, diseased worms, and worms hatched from diseased eggs, and in all these, after being near the emanations from his newly-discovered specific, the infection was entirely arrested. He employs merely coal-tar, placed in shallow vessels, about the chambers where the worms are contained, and according to his account, the manner in which the vapour (probably carbolic acid) of this agent affects the worms is remarkable. This plan, it will be seen, is one of the easiest to put into practice. Not only is the expense insignificant, not only can coal-tar be obtained wherever gas is burned, but its employment renders necessary no alteration whatever in the arrangements of the chambers. All that is necessary is, to place *the vessels of* coal-tar in some out-of-the-way places, and *leave them to themselves*, renewing them at rare intervals.

BOTANY.

LIGHT AND PLANTS.

DR. DAUBENY has read to the British Association a paper "On the Influence of Light on the Function of Plants." The author described certain principles published by him in the *Philosophical Transactions* in the year 1836, in the course of which he established, firstly, that the decomposition of carbonic acid and the consequent disengagement of oxygen was influenced chiefly by the luminous rays of the spectrum, and not by the calorific or actinic ones; secondly, that under particular circumstances, nitrogen is emitted during sunlight from the leaves of plants; thirdly, that other functions of plants, such as the greenness which the leaves assume, the peculiar property which belongs to certain ones, as to the sensitive plant, the exhalation of water from the leaves and its absorption by the roots, are probably dependent upon the same influence, &c. Dr. Daubeny briefly reviewed the various points comprised in the subject he selected for consideration, and submitted representations on paper illustrative of the operations of light under various circumstances.

SELECTIVE POWER OF PLANTS.

DR. DAUBENY has read to the British Association, a paper "On the Functions discharged by the Roots of Trees," and made some observations "On a Violet peculiar to the Calamine Rocks, in the neighbourhood of Aix-la-Chapelle." In these papers the author called attention to the selective power possessed by the roots of plants as indicative of a force independent of any explanation from physical causes, and which he therefore regarded as vital.

Dr. Lankester objected to the term "vital" as indicating the existence of a force independent of physical forces. All we knew of the functions of animals and plants increased the conviction that they were dependent on physical forces. The selective power of roots was no greater proof of a vital action than the selective power possessed by the crystals of minerals on compound solutions.

VITAL FORCE IN PLANTS.

DR. JEPEN has communicated to the British Association a paper "On the Absorbing Power of the Roots of Plants," which he had written since he had been in Manchester, in consequence of the discussion above referred to, between Dr. Lankester and Dr. Daubeny. Dr. Daubeny was quite ready to allow that the term "vital force" was conditional. At the same time he felt that some of the phenomena of plant life could not be explained by physical causes. Such, he thought, was the power plants had of selecting one kind of food rather than another, and the power the leaves possessed of decomposing carbonic acid. He then gave some account of *Prof. Graham's* recent researches, in which he showed that all sub-

stances were of two kinds, colloid and crystalline; and that the latter passed into membranes, whilst the former would not. He thought these experiments of Mr. Graham would throw great light on physiological problems. Prof. Williamson expressed his conviction that the processes of life did not depend on physical causes. There were always causes acting in the life of plants and animals that no physical principles with which we were acquainted could explain. He instanced the fact of a Hydra taking one of its own tentacles into its stomach with an animalcule. It digested the animalcule, but its tentacle suffered no harm. Mineral bodies were subject to no decay as organic bodies were; and it was this death that showed the existence of a departed vital force from the dead plant or animal. Mr. Lubbock thought the danger of using the term "vital" force or principle was, that persons who employed it thought it explained the phenomena, which in no instance was the case. He thought that the death of marine animals in fresh water, and of fresh-water animals in salt water, was an instance of how physical circumstances influenced life. Dr. Lankester said, that the term "vital force" had been used in various senses, and Dr. Daubeny only accepted it as a provisional term. What he wished to point out was, that in the sense in which it was employed by Dr. Daubeny, it was only equivalent, as Dr. Jepen had stated, to the "crystallizing force" of minerals, which exercised the same selecting power in crystallizing as the roots of plants did in growing. The only phenomena in plants for which we had really no physical explanation were, the movements of the protoplasm in the interior of the cells of plants, and the locomotive power of unicellular plants and their cilia. These movements were similar to the muscular contractility and nervous sensibility of the highest animals. These movements were, however, dependent on physical causes, and the chemical decomposition of the sugar and protein of our food was necessary for their development. As to death not occurring in the mineral world, this was but another name in animals and plants for change; and change occurred in crystals and in all the physical phenomena of the universe, as much as in organic bodies.

PINE WOOL.

NEAR Breslau, in Silesia, are two establishments erected by M. Pannewitz—one a factory where Pine leaves are converted into a kind of Cotton or Wool, the other an institution for invalids, in which the waters used in the manufacture just mentioned are employed curatively. The material, called also "woody wool," can be curled, woven, or felted. We do not know M. Pannewitz's method, but it is stated that a fibrous material can be obtained from pine leaves by boiling in alkaline liquors, and saturating them in a solution of chloride of lime. Blankets made of pine wool have been extensively sold in Vienna, and jackets, stockings, and other articles of dress are now made of this material. In the preparation of the wool an *ethereal oil is produced,* which is said to be a valuable addition to the

materia medica. Further particulars will be found in the *Technologist.*

RIBBON FLOWERS.

THE beautiful Ribbon Flower-bed, fifty feet in length by seven in breadth, has been the leading attraction of the season at Kew Gardens. The flowers are exceedingly brilliant, at the climax of their autumnal beauty. All the great centres of English industry are stated in the *Athenæum* to have sent agents and artists to copy it, as a design and pattern for part of the goods they are making for the Great Exhibition of 1862, viz.—Manchester, *prints, chintz, draperies, &c.;* Coventry, *ribbons;* Kidderminster, *carpets;* Glasgow, *muslins, shawls, &c.;* Yorkshire, *coloured table covers;* Belfast, *damask table linen, &c.;* Nottingham, *lace;* Macclesfield, Derby, and Spitalfields, *silks, embroideries, &c.;* Dublin, *mixed fabrics;* Paisley, *Scotch goods and window muslins;* Bradford, *moreens and damasks;* Clerkenwell, *artificial flowers;* and the Potteries, *china and porcelain.*

THE CINCHONA IN INDIA.

DR. BRANDIS, of Rangoon, has published an official memorandum on the suitability of the Burmese hill ranges for Cinchona cultivation, and on the best site for a Sanitarium there. He would not commence cinchona-growing on any of the mountain ranges until the experiment has been more fully established in those localities in India where it is now being tried. But when the time comes for introducing the cultivation into our eastern provinces, Dr. Brandis recommends as the most suitable spot the collection of mountains between the Salween and Sittang, known as the Yoonzaleen range. They appear to form an equilateral triangle with Rangoon and Moulmein. A little southward of the spot in question the mountains become a distinct watershed between the Salween and the Sittang. In South America the cinchona is found at an elevation of from 3000 to 6000 feet, in the immediate neighbourhood of mountain masses which rise up to 18,000 feet and are partly covered with eternal snow. The Yoonzaleen mass contains peaks from 5000 to 8000 feet high. The rainfall is greater than in the plains, and the temperature lower and more uniform. The rocks are granite, gneiss, and quartz. The vegetation is entirely tropical up to an elevation of 3000 feet, when teak disappears, and pine forests begin. The population of the region is not above 1500 souls.—*Friend of India.*

THE COCOANUT-TREE.

A PAPER on this majestic tree and its uses, read by Dr. Hugh Cleghorn at a meeting of the Edinburgh Botanical Society, appears in the *Edinburgh New Philosophical Journal.* We have only room for a few notes:—The genus cocos, by far the most important of the palm tribe, contains twelve species, of which the cocoanut-tree (*cocos nuciferi* of Linnæus) is the most valuable. There are many

varieties, five being indigenous to Ceylon. It is found all over the tropical parts of the world, growing from sixty to eighty feet high. Its fruitfulness varies with the soil, and it seems partial to the sea-shore. Possessed of a habitation darkened by a clump of cocoanuts, a jak, and a palmyra-tree, a native of India is considered a landed proprietor. The leaves are serviceable also for thatch, screens, baskets, and mats; the fibrous coating of the fruit forms a rope, and is used for stuffing mattresses; and the kernel furnishes a rich clear oil. The tree is propagated by nuts, which, when planted thoroughly ripe about May, come up usually about November. The first leaf is single, and the plant is transplanted before it divides. The tree begins to bear in seven years; in fifteen years is in full bearing, producing about sixty or seventy nuts, and continues bearing from seventy tô eighty years. Dr. Cleghorn describes the mode of extracting the toddy, and gives engravings, showing the native equipped for the ascent, his apparatus, &c. When the spathe of the tree is ready to yield toddy may be known easily by the chattering of birds, the crowding of insects, the dropping of the juice, and other unmistakable signs. In 1858, 2,508,869 cocoanuts were imported into the United Kingdom, and were almost all retained for home consumption. They are used instead of wedges to fill up the interstices between casks and packages in the cargoes of ships, so that the freight costs little. In the same year our imports of cocoanut oil amounted to 197,788 cwt.—*Mechanics' Magazine.*

THE NEW GARDENS OF THE HORTICULTURAL SOCIETY,

At South Kensington, were opened on June 5. They are intended to form hereafter the inner court of a vast quadrangle of public buildings, of which a portion of those for the International Exhibition will form a portion. The gardens are a rectangular plot of 22 acres, laid out by Mr. Nesfield in the trim style.

The conservatory, of glass and iron, has been erected by Mr. Kelk, from the designs of Capt. Fowke, at the northern extremity of the gardens: it is 263 feet long and 95 feet 9 inches wide, exclusive of a projection of 7 feet 6 inches on the north side of it. The extreme height of it is 75 feet 6 inches. The height from the floor to the top of the iron columns is 39 feet; from the floor to the gallery 22 feet 6 inches. The span of the arched roof is 45 feet. The columns are 15 feet apart. The amount of the contract for the conservatory was about 14,500*l.*, and the whole cost (adding 1000*l.* for the engine-house and 200*l.* for the chimney) may be called 16,000*l.* There is an arcade, with flights of stairs leading to the gallery and to the top of the upper arcades in the garden, on either side of the conservatory. The arcade in the conservatory is formed with terra cotta columns, 8 feet 6 inches high, including cap and base, and ornamented brick arches. The terra cotta is supplied by Mr. Blanchard: the ornamental work executed in it was designed and modelled by Mr. Godfrey Sykes.

In front of the centre of the conservatory, at the head of the lake, is to be placed the Memorial of the Great Exhibition of 1851, originally intended to have been surmounted by a statue of the Queen; but now to receive a statue of the lamented Prince Consort. Still, would not the more appropriate site for this Memorial, to be erected as a public tribute, be the Exhibition site in Hyde Park, where it was originally intended to be placed?

Geology and Mineralogy.

THE AGE OF MANKIND.

At the late Meeting of the British Association, (Geological Section,) the following contributions on this question were read:—

First was a paper by Mr. W. Pengelly, on "A new bone cave at Brixham, in Torquay;" containing an exposition of the geological features of the district where these caves abound, and of the circumstances under which some curious bones were found.

The next paper was one by Mr. J. H. Barrow, and entitled, "Remarks on the bone caves of Craven, in Yorkshire," chiefly referring to the discoveries of organic remains which have been made in these caves, by Mr. Jackson, of Settle. Several interesting specimens were produced. The discoveries, besides animal remains of bears, wolves, the tooth of a tiger, remains of a hyæna, &c., also included many human remains, in skeletons, skulls, and other bones; also arrow-heads, flint implements, coins, pottery, and other articles, which were chiefly found in the clay flooring of the caves.

Some remarks on the question as to the probable antiquity of these various remains, were made by Professors Phillips and Rogers. Professor Phillips especially referred to the agencies which are and have been at work, and which must have had an important influence in removing the remains originally deposited in one bed to quite a different one, proofs of which must constantly be occurring to every practical geologist. He denounced entirely the supposition that time can be accurately measured by geological phenomena.

Sir R. I. Murchison concurred entirely in Professor Phillips's observations.

Professor Rogers gave some interesting facts, to show that bones of extinct animals, found with human bones, are not decisive proofs that those animals and man both lived at the same period, but might have been brought together by the agency of water, or other natural actions.

Mr. W. Pengelly replied at some length. He believed, from the features represented at Brixham, that man lived at the same period with the animals whose bones had been found near the human bones.

M. Boucher de Perthes has published a *Reply to Observations by M. E. Robert, regarding the Diluvium of the Department of Somme.* M. E. Robert, at the meeting of the Paris Academy of Sciences, on January 14, had made some objections to the conclusions of M. Boucher de Perthes, regarding the implements of flint found at Amiens and Abbeville. Then, M. E. Robert alleged that the *diluvium in* which these implements were found was modern, but *had not,* as M. Boucher de Perthes stated in his reply, seen the

localities named. For about twenty-five years has this latter gentleman been labouring to prove the antiquity of the human race, and its existence at the same time as the larger mammiferous animals now extinct, yet he states that very few have remained incredulous after one careful examination of the locality. Those who confound the new with the old diluvium must be prepared to show how it happens that these beds are to be found in places so widely apart as Paris, Cltchy, Creil, Amiens, Abbeville, and at Hoxne and Bedford in England. M. Boucher de Perthes concludes from this examination of the whole question, that the diluvium in which are found these fossil bones, and flint hatchets—and consequently the human race—existed before the Continent and the British islands were separated by the convulsion which opened the Straits of Dover. We suppose M. Boucher de Perthes does not give any credit to gorillas, or similar intelligent animals, for the manufacture of these primodiluvian hatchets and flint tools.—(See *Year-Book of Facts*, 1861, for several contributions upon this important inquiry).

DEVONIAN AGE OF THE WORLD.

MR. PENGELLY has concluded his course of lectures on this subject with the following details of those remarkable animals of the molluscous class, the Cephalopoda (literally, head-footed), which are divided into the Dibranchiata and the Tetrabranchiata, the former having two, the latter four, breathing organs. All the Cephalopoda are marine and predaceous. The common cuttle-fish (*Sepia officinale*) is a well-known example of the Dibranchiata. It is sometimes six feet long. With its powerful parrot-like mandibles it seizes and devours fish with great voracity, and sometimes takes a piece out of the hand of the fisherman. It possesses an internal shell or bone (from which pounce is made), an ink-bag, and powerful arms provided with suckers. It is able to crawl on to the shore, and swim in the water by a kind of hydraulic arrangement. Its brain is protected by a strong cartilage approaching the character of bone, and it manifests great dexterity in capturing its prey and avoiding danger. Mr. Pengelly exhibited a diagram coloured by the pigment obtained from a fossil ink-bag. The Palæozoic Cephalopods, all Tetrabranchiata, are divided into three families, the Nautilidæ, Orthoceratidæ, and the Ammonitidæ, and are all represented in Devonian rocks. The fossil Orthocerata and Ammonites attained enormous dimensions, and began, flourished, and became extinct thousands of years ago. The wonderful structure and divisions of their chambered and sutured shells were dwelt upon by Mr. Pengelly, and exhibited in diagrams and fine specimens. They exhibit many of the arrangements adopted by architects for giving strength and beauty to their edifices.

BONE-CAVES.

THERE has been read to the Geological Society a "Description of *two Bone-Caves in the* Mountain of Ker, at Massat, in the Depart-

ment of the Arriège," by M. Alfred Fontan. Communicated by M. E. Lartet, For. Mem. G.S.

The valley of Massat, on the northern side of the Pyrenees, is of a triangular shape, its northern angle being narrowed by the projecting limestone mountain of Ker. Among the fissures and grottoes that traverse this mountain in every direction are two caves in particular: one is situated near the top, at about 100 mètres above the valley; the other is near the base, at about 20 mètres above the river. They both open towards the north. In the upper cave M. Fontan found a sandy loam with pebbles (the pebbles being of rocks different from that of the mountain), extending inwards for 100 mètres, and containing a large quantity of bones of *Carnivora*, *Ruminantia*, and *Rodentia*—those of the great Cave-bear, a large *Hyæna*, and a large *Felis* being the most numerous. On the surface some fragments of pottery, an iron poignard, and two Roman coins were found, with a quantity of cinders and charcoal; and at a depth of more than three feet in the ossiferous loam another bed of cinders and charcoal was met with, and in this M. Fontan found a bone arrow-head and two human teeth; the latter were at a distance of five or six mètres one from the other.

In the lower cavern a blackish earth, with large granitic and other pebbles, was found to contain bones of the Red Deer, Antelope, Aurochs, and Lynx; also worked flints and numerous utensils of bone (of deer chiefly), such as bodkins and arrows; the latter have grooves on their barbs, probably for poison. Some of the bones bear marks made of incisions by sharp instruments in flaying or cutting up the carcases. In each cavern a chasm crosses the gallery and terminates the deposits—in the upper cave at 100 mètres, in the lower one at about seven mètres from the entrance.

The author argues that, from the facts which he has noticed, these caverns must have been subjected simultaneously to the effects of a great transient diluvial cataclysm coming from the N.N.W. or West, in the opposite direction to the present course of the waters of that region; that man and all other animals, the remains of which are buried in these caves, existed in the valley before this inundation; and that the greater part of the animals inhabited the caves, but that man was not contemporary with all of them.

FLINT IMPLEMENTS IN THE DRIFT.

Mr. Prestwich has communicated to the Geological Society the following "Notes on some further Discoveries of Flint Implements in the Drift; with a few suggestions for search elsewhere."

Since the author's communication to the Royal Society in 1860, on the discovery of flint implements in Pleistocene beds at Abbeville, Amiens, and Hoxne, similar implements have been found in some new localities in this country.

In Suffolk, between Icklingham and Mildenhall, Mr. Warren has met with some specimens in the gravel of Rampart Hill in the valley of the Lark. This gravel is of later date than the Boulder-

clay of the neighbourhood. In Kent, Mr. Leech, Mr. Evans, and the author found some specimens at the foot of the cliffs between Herne Bay and the Reculvers. The author believes them to have been derived from a freshwater deposit that caps the cliff, and which has been found by Mr. Evans and himself to yield similar specimens at Swale Cliff, near Whitstable. In Bedfordshire, Mr. J. Wyatt, F.G.S., has found some specimens in the gravel at Biddenham, near Bedford; this gravel also is of freshwater origin, and is younger than the Boulder-clay. In Surrey, a specimen found in the gravel of Peasemarsh, twenty-five years ago, has been brought forward by its discoverer, Mr. Whitburn, of Guildford. In Herts, Mr. Evans has found a specimen in the surface-drift on the Chalk Hills near Abbots Langley. Lastly, the author recommended that diligent search be made in the gravel and brick-earth at Copford and Lexden, near Colchester, at Grays and Ilford, in Essex, at Erith, Brentford, Taplow, Hurley, Reading, Oxford, Cambridge, Chippenham, Bath, Blandford, Salisbury, Chichester, Selsea, Peasemarsh, Godalming, Croydon, Hertford, Stamford, Orton, near Peterborough, &c.

NEW ZEALAND GOLD-FIELDS.

The newly-discovered Gold-fields at Tuapeka, about thirty miles from Tokomairiro, were thus described by Mr. Gillies, a member of the Provincial Council, towards the end of June. He says the gold is found in some places lying on the flat surface of the blue slate rock, and in one rich claim it lay sprinkled about like oats sown in a field. In others, and more generally, it is found in ledges of the rock and deposited in the hollows, where the ledge or hollow crosses what has formerly been the course of the stream. In some places it is embedded in the blue slate rock several inches, and it is to be found in the quartz. From careful inquiries of at least 100 persons who had been longest at work, he was convinced that their average earnings had been over two ounces per man per day, and that the average earnings of all who had been at work with proper appliances would be at least an ounce a day. One party averaged 4 oz. 16 dwts. per man per day. In one day a party of seven took 38 ozs. for their day's work, and other remarkable finds had been made, such as from three-quarters to an ounce of gold to a tin dishful of washing stuff. Mr. Gillies is of opinion that the gold is distributed over a large tract of country, and that it is likely to be a permanent as well as a rich gold-field. The country around is beautifully grassed, and in the Tuapeka and Waitahuma valleys there is some of the richest agricultural land in the province. About 1000 men were on the spot, and the greatest harmony and cheerfulness prevailed. The Lindis gold-fields have not realized the great expectations formed of them.

We quote the following from a letter from New Zealand in the *Times*, Nov. 15, 1861:—"It has been long known that gold exists in New Zealand, but until lately it was believed not to be in paying

quantities. Gold was found years ago at Coromandel harbour in the North, but although it was trumpeted as the 'New Zealand gold-fields,' it was soon abandoned as not yielding common wages. Then came the discovery of gold at Massacre Bay, in the province of Nelson; there the diggers continued to work, but they were few in number, and their success was at no time such as to tempt our diggers from our richer fields. About two years ago Professor Hefstetter, who travelled in New Zealand, expressed his opinion on his return to Melbourne, on his way to Europe, that geologically New Zealand presented all the features of a country rich in gold. Within the last three months discovery has followed discovery in rapid succession, and the gold-fields of Otago are now an acknowledged fact. The first event of consequence which excited the public mind here was the transmission of 3000 ounces from Dunedin to Sydney. Then came the steamer *Oscar* to Melbourne, on the 7th of September, with 5827 ounces. The *Omeo* came in with 6900 ounces, and the *Aldinga* arrived with 2400 ounces. We obtain by these arrivals authentic official intelligence which enables the miners to calculate their own chances of success with some approach to accuracy. The escort of the 21st of August took down to Dunedin 5066 ounces, that of the 4th of September, 7750 ounces, and that of the 18th of September, 11,181 ounces. The quantity obtained in the month of August was about 16,000 ounces, and the number of diggers was under 3000. This would average about 20*l*. a head. Indications of gold have also been found in other places. In digging a well at Canterbury a small nugget was turned up at a depth of sixty feet, and in the Karori stream, near Wellington, small particles have been found. These indicate an auriferous country."

GOLD IN NOVA SCOTIA.

The Earl of Mulgrave, Governor of Nova Scotia, has forwarded to the Colonial Office information on the subject of the recent discovery of Gold Quartz near Tangier harbour, about half-a-mile from the seashore, and forty or fifty miles east of Halifax. He reports that he visited the spot last month, and found there were nine different lodes running about east and west, and, it is believed, extending for a very considerable distance. The lodes are narrow, varying from about three inches to three feet, the smaller lodes being the richest, and the gold generally found on the outsides of the lode. Only the most primitive mode of searching has hitherto been adopted, the quartz being taken out and broken up with a hammer, and the gold picked out by hand; but, nevertheless, a considerable quantity has been found. Two men working in one claim secured about 30*l*. worth in a week from first breaking ground, but that was probably the best yield, and on an average the parties were doing nothing more than making good wages, if that.

RISE OF THE COAST OF THE FTIRH OF FORTH.

MR. ARCHIBALD GEIKIE concludes a paper contributed to the *Edinburgh New Philosophical Journal* as follows :—

Having shown that the coast at Leith has risen 25 feet or so since the Roman invasion, it by no means follows that the coast along other portions of the Firth of Forth, and of the east of Scotland generally, has been elevated to the same amount.

Such movements are local in action and variable in amount, so that geologically there is no reason why the amount of rise may not have lessened towards the west, until in the Firth of Clyde it ceased altogether. No one can examine the shores of our country without becoming convinced that they have been raised, not by equal and uniform elevations, but by a general upheaval which varied greatly in amount in different localities, and was even interrupted by long intervals, during which the land appears to have remained stationary. Hence the raised beaches occur at different levels above the present shore, and even the same line of upheaved littoral deposits may be proved to be actually higher at one point than at another.

In conclusion, as some of the more widely-known geological researches of the last two or three years have been directed to the history of primæval man, every additional fact that tends to place in a clearer light the relations of our race to the later physical changes of the land, acquires at present a peculiar significance. The object of this paper has been to show that the last elevation of part of Britain has not only taken place since the island was inhabited by man, but even since it was invaded by the Romans. The extent of this upheaval has been at one locality as much as 25 feet—a large amount of change to have taken place quietly and unobserved during a period of less than 1800 years. In the centuries that preceded this elevation, other changes of equal or even higher magnitude may have been going on, possibly with a still greater rapidity, after man had become an inhabitant of these islands. Some caution, therefore, is needed, lest the extent of the geological changes which he has witnessed should lead us to assign to man, as an inhabitant of Britain, a higher antiquity than he can justly claim.

PRIMÆVAL ROCKS.

SIR R. I. MURCHISON, in his opening the business of the Geological Section of the British Association, has given an address of much interest on those Primæval Rocks with which his own researches had for many years been most connected, with some remarks on Metamorphism.* He now finds it impossible to refuse any longer to believe that a mechanical deposit may have become crystalline (while others of the same epoch continue mechanical still), and that without any exposure to such heat as could destroy organic remains. For such phenomena in metamorphism, indeed, he still finds him-

* We take this opportunity of directing attention to "The First Lines of Morphology and Organic Development, Geometrically considered," in the *Edinburgh New Philosophical Journal*, No. 27, N. S.—ED. Year-Book.

self unable to account; but if he will refer to an article in *Jameson's Journal*, so far back as November—January, 1833, p. 132, he will find himself invited to such discoveries as he and other geologists are now making; the change from the confused and mechanical structure to the crystalline (or condition of molecular repose) being there shown to demand, in favourable circumstances, no more heat than that which specifically actuates all molecules.—*Edinburgh New Philosophical Journal.*

RECENT ENCROACHMENTS OF THE SEA.

MR. W. PENGELLY has read to the British Association a paper, "On the Recent Encroachments of the Sea on the Shores of Torbay." Hard Devonian limestones, fissile and round-jointed, formed, he said, the two projecting horns of Torbay. Sandstones and conglomerates form the hollow of the bay, and have been much worn away within the memory of man, especially at Livermead, which is only preserved by continual engineering labour. The process of erosion by the sea was explained by the author as something like a succession of honeycombing, sometimes by insulations of portions of the cliffs. On the slates and limestones the sea more slowly produced excavations and ledges, which storms enlarge. The effects of the severe storm of October, 1859, on the cliffs, beach, roads, &c., of Torbay, were described in detail, and the importance of such storms as modern agents of change was dwelt upon.

INCREASE OF LAND ON THE COROMANDEL COAST.

MR. J. W. DYKES, in a letter to Sir Charles Lyell, states that—In the districts of the Kistna and Godavery, the land presents a parallel series of ridges and hollows near the coast, not in relation to the rivers, but to the coast-line. These may have been formed by sedimentary deposits similar to what are now taking place on the Coromandel Coast. By the strong currents alternately running N. and S., according to the monsoons, lines of sediment parallel with the coast are formed; and by the occasional interference of winds and tides, dams are thrown across the hollows, and the latter soon become filled up. These parallel bands of coast-land become in time upheaved, and more or less affected by atmospheric agencies. —*Proc. Geolog. Soc.*

SILURIAN ROCKS OF IRELAND.

MR. W. H. BAILY has read to the British Association, "Palæontological Remarks upon the Silurian Rocks of Ireland." In this paper the author noticed the occurrence of Llandello flags in the county of Meath containing the characteristic graptolite *Didymograpsus Murchisonii*, and then proceeded to give a general review of the localities in Ireland from which fossils were obtained, as affording satisfactory evidence of the various subdivisions of the Silurian rocks at present ascertained in that country.

THE EARTH'S CRUST.

THE REV. R. EVEREST has stated to the Geological Society, that by drawing on a chart a line traversing the deepest soundings along the English Channel and the eastern coast of England and Scotland, continuing it along the 100-fathom-line on the Atlantic side of Scotland and Ireland, and connecting with it the line of the deepest soundings along St. George's Channel, an unequal-sided hexagonal figure is described around the British Isles, and a pentagonal figure around Ireland. A hexagonal polygon may be similarly defined around the Isle of Arran. These lines limit areas similar to the polygonal form that stony or earthy bodies take in shrinking, either in the process of cooling or in drying. After some remarks on the probable effect that shrinkage of the earth's crust must have on the ejection of molten rock, the author observed that, in his opinion, the action of shrinking is the only one we know of that will afford any solution of the phenomena, namely, long lines of depression accompanied by long lines of elevation ; often, as in the case of the British Isles, Spain and Portugal, and elsewhere, belonging to parts of huge polygons broken up into small ones, as if the surface of the earth had once formed part of a basaltic causeway.

DINOSAURIAN REPTILE FROM CHARMOUTH.

PROFESSOR OWEN has read to the British Association, a paper "On a Dinosaurian Reptile (*Scelidosaurus Harrisoni*) from the Lower Lias of Charmouth." He said the reptile belonged to the remarkable order exhibiting modifications of the reptilian structure, as we now knew it in crocodiles and lizards, as adapted for life on land. The remains had been found in the upper green sand deposits of our cretaceous system, downward through the wheildon, and as regarded the megalosaurus as far down as the great oolitic bed ; but until very recently that was the oldest formation from which any evidence of a dinosaurian reptile had been the property of science. Mr. Harrison, a retired medical gentleman at Charmouth, on the Dorset coast, about three years ago obtained, from a part of the cliff which was an upper member of the lower lias, some fragments of limb bones, of so novel a character that he sent them to him (Professor Owen) for his opinion. He was surprised to receive such things from that locality and formation. Mr. Harrison was quickened in his researches by such a reply, and at length he received the most complete skeleton of a dinosaurian reptile ever obtained from any formation or locality. The skull was entire, with the exception of the end of the snout—in fact, it was entire for all the purposes of the comparative anatomist. So were the neck and trunk vertebræ, the sacrum, the pelvis, and a great portion of the vertebræ of the tail. Professor Owen described in detail the various portions of the skeleton, pointing out where they nearly resemble those of the ignanodon and the megalosaurus.

PLESIOSAURUS FROM NEW ZEALAND.

PROF. OWEN has read to the British Association, a paper "On the Remains of a Plesiosaurian Reptile (*Plesiosaurus Australis*), from the Oolitic Formation in the middle island of New Zealand." The author remarked that it had been said that "the further we penetrate into time for the recovery of extinct animals, the further we must go into space to find their existing analogies;" and that "in passing from the more recent to the older strata, we soon obtain indications of extensive changes in the relative position of land and sea." The mosasaurus of the cretaceous series occurs in that series in England, Germany, and the United States. The polyptychodon occurs in the same series at Maidstone and at Moscow. Toothless lacertian reptiles have left their remains in triassic deposits at Elgin, in Shropshire, and at the Cape of Good Hope. The plesiosaurus, with a more extensive geological range through the jurassic or oolitic series, has left representatives of its genus in those mezzozoic strata in England and at her antipodes. The Professor minutely described the fossils, pointing out the confirmatory evidence that they were plesiosaurian; the most decisive proofs being drawn from the vertebral centrums. The specimens are now in the British Museum.

CYRENA FLUMINALIS.

MR. PRESTWICH has read to the Geological Society, a paper "On the Occurrence of Cyrena Fluminalis associated with Marine Shells in Sand and Gravel above the Boulder-clay at Kelsey-hill, near Hull." The author's observations tended to show that the Cyrena fluminalis, instead of being limited in its occurrence to beds beneath the Boulder-clay (under which circumstance it is found in Norfolk), occurs in deposits of newer date, and that the argument, that the well-known beds at Grays, in Essex, are older than the Boulder-clay, depending much on the presence of this shell, would lose much of its force if this Cyrena were proved to belong also to the newer geological horizon. The question is now the more important, as this shell has been found by Mr. Prestwich in the beds that contain flint implements at Abbeville.

The author proceeded to show that some gravels and sands near Hull, in Yorkshire, formerly described by Professor Phillips, contain abundance of the Cyrena fluminalis, associated with twenty-two species of marine shells, two of which have Arctic characters, the others being common littoral forms. These gravels and sands were proved, by well-sections and other exposures, especially by borings and trenches made by the author and Mr. T. J. Smith, of Hull, to overlie the Boulder-clay.

ANCIENT GLACIERS.

MR. DAVID MILNE-HOME has communicated to the *Edinburgh New Philosophical Journal*, some "Notes on Ancient Glaciers, made during a brief Visit to Chamouni and its Neighbourhood, in Sep-

tember, 1860," in which he details the results of his examination of these phenomena, and concludes as follows: I infer that this depression and submergence took place at a period posterior to the transportation of the erratic blocks, because these blocks (as I have shown) are in many instances enveloped in the heart of the stratified beds.

Then this submergence was followed by a re-elevation of the country to its present levels.

Thus, immediately before the transportation of the blocks, the country was successively depressed and elevated; and immediately after that event these operations were repeated, so that there need be little reluctance in adopting the view suggested for explaining the extension of these ancient glaciers.

My view, then, of the sequence of events is as follows:—

1. This district of Switzerland stood above the sea 3000 feet higher than at present. Glaciers then filled the valley of Chamouni, passing over the hill of Chavant, producing the scratches and furrows mentioned in a previous part of this paper, and descended as far as the Salève mountains, depositing blocks in its course and at its termination. Glaciers filled also the whole valley of the Rhone, and reached the basin now occupied by the Lake of Geneva; and then turning westward towards Geneva, spread everywhere loads of alpine detritus, and lodged huge blocks on the mountain-sides.

2. Next came a period when the land gradually sunk, and when, of course, the temperature rose, so that the glaciers shrunk back to the higher parts of the valleys.

The land was then submerged beneath the waters of a deep sea, and the glacial deposits were arranged into the stratified beds before referred to; but these deposits were not so entirely rearranged as to lose all the outward features of their glacial origin. In particular, they still retained the gradual slope from the mouth of the Rhone towards the west, which they must have had when deposited by a glacier.

During this period of submergence, when, as we have seen, the land was lower than at present by so much as 3000 feet, the climate of Switzerland was probably better than it has been since; in which case we obtain a better explanation than has yet been given of the discovery of the bones of elephants, antelopes, and some other animals, requiring a mild climate, in quarries of gravel in different parts of Low Switzerland.

During this period the glaciers must have been very much smaller than at present, and many of them would not exist.

3. Then followed the last movement, when the country rose up to its present levels, and when, of course, the glaciers would again enlarge, but to a more limited extent.

This last movement may have been gradual, or it may have been sudden. Of course, the more sudden it was, the more easily can we account for the removal of detritus from the valleys, which has taken place to so great an extent, as is well marked by the terrace along the course of the Arve and the Rhone.

AN ALPINE OBSERVATION.

PROF. TYNDALL has communicated (Oct. 21,) to *The Times* the following very interesting record:—

Many years ago, Mr. William Hopkins, of Cambridge, pointed to the state of the rocks over which glaciers had passed as conclusive

evidence that these vast masses of ice move bodily along their beds. Those rocks are known to have their angles rasped off, and to be fluted and scarred by the ice which has passed over them. Such appearances, indeed, constitute the entire evidence of the former existence of glaciers in this and other countries, discussed in the writings of Venetz, Charpentier, Agassiz, Buckland, Darwin, Ramsay, and other eminent men.

I have now to offer a proof of the sliding of the ice exactly complementary to the above. Suppose a glacier to be a plastic mass, which did not slide, and suppose such a glacier to be turned upside down, so as to expose its under surface; that surface would bear the impression of its bed, exactly as melted wax bears the impression of a seal. The protuberant rocks would make hollows of their own shape in the ice, and the depressions of the bed would be matched by protuberances of their own shape on the under surface of the glacier. But, suppose the mass to slide over its bed, these exact impressions would no longer exist; the protuberances of the bed would then form longitudinal furrows, while the depressions of the bed would produce longitudinal ridges. From the former state of things we might infer that the bottom of the glacier is stationary, while from the latter we should certainly infer that the whole mass slides over its bed.

In descending from the summit of the Weigshorn on the 19th of August last I found, near the flanks of one of its glaciers, a portion of the ice completely roofing a hollow, over which it had been urged without being squeezed into it. A considerable area of the under surface of the glacier was thus exposed, and the ice of that surface was more finely fluted than ever I have observed rocks to be. Had the tool of a cabinetmaker passed over it, nothing more regular and beautiful could have been executed. Furrows and ridges ran side by side in the direction of the motion, and the deeper and larger ones wre chased by finer lines, produced by the smaller and sharper asperities of the bed. The ice was perfectly unweathered, and the white dust of the rocks over which it had slidden, and which it had abraded in its passage, still clung to it. The fact of sliding has been hitherto inferred from the action of the glacier upon the rocks; the above observation leads to the same inference from the action of the rocks upon the glacier. As stated at the outset, it is the complementary proof that the glacier moves bodily over its bed.

MOVEMENT OF GLACIERS.

HER Britannic Majesty's Consul at Geneva has communicated to the *Times* the following information illustrative of the movement of the great glaciers of Switzerland and Savoy:—

"Your readers will all remember the tragic end of Auguste Tairaz, Pierre Balmat, and Pierre Carrier, the three Chamounix guides, who were swept from the Grand Plateau by an avalanche on the 20th of August, 1820, while making, or attempting, the ascent of Mont Blanc with Dr. Hammel, and, I believe, some Genevese gen-

tleman. No traces whatever of these poor fellows had ever been discovered from the moment of their destruction till this morning (August 15), when the following fragments were found on the lower part of the Glacier des Bossons, entering the valley.

"The fragments found consist of—

"1. An arm in the most perfect state of preservation, with the hand, fingers, nails, skin, and dried frozen flesh intact, in noways discoloured; part of little finger only gone. The length of this limb extends to the elbow.

"2. Parts of two different skulls, with a good deal of hair remaining with the skin on both; one belonging to a fair man, the other to a dark one. The hair most wonderfully preserved in colour, &c. One of these fragments was recognised by Julian Devoussoux (a survivor of the 1820 ascent) as being that of Pierre Balmat.

"3. Part of a guide's knapsack, with sundry portions of a lantern attached to it.

"4. An iron crampon, which the guides at that time strapped on their shoes when they crossed the glaciers, &c., to prevent slipping.

"5. Several portions of guides' dress—cravats, hats, torn portions of linen, portions of cloth coats, &c., all easily distinguishable as belonging to men of the guide class.

"The fragments were found by a guide and an English gentleman, who wished to visit the lower Glacier des Bossons, about two hours' walk from Chamounix, and they came quite unexpectedly upon these most interesting remains.

"Two of the guides who formed part of this memorable ascent are still alive—Julian Devoussoux and Jacques Coutel—and I understand from an English friend of mine that Dr. Hammel still lives in England, and no doubt he will be much interested in this discovery.

"Professor Forbes has repeatedly told the Chamounix guides that they might look out for traces of their deceased comrades in the Lower Bossons in about forty or forty-five years after the catastrophe. He told Auguste Balmat in 1858 to keep a look-out. Bearing all this in mind, what a satisfactory event this finding of the fragments, within the period calculated by the Professor, becomes to men of science, studious of the laws of nature, who seem thus, apparently, almost able to calculate by outward signs what is going on in the depths of the earth!"

PETROLEUM SPRINGS IN NORTH AMERICA.

Dr. A. Gesner has described to the Geological Society the following new sources of Petroleum.

After some observations on the antiquity of the use of mineral oil in North America and elsewhere, and on the present condition of the oil and gas-springs and the associated sulphur and brine-springs in the United States, the author stated that 50,000 gallons of *mineral oil are daily* raised for home use and for exportation. The

oil-region comprises parts of Lower and Upper Canada, Ohio, Pennsylvania, Kentucky, Virginia, Tennessee, Arkansas, Texas, New Mexico, and California. It reaches from the 65th to the 128th degree of long. W. of Greenwich, and there are out-lying tracts besides.

The oil is said to be derived from Silurian, Devonian, and Carboniferous rocks. In some cases the oil may have originated during the slow and gradual passage of wood into coal, and in its final transformation into anthracite and graphite, — the hydrogen and some carbon and oxygen, being disengaged, probably forming hydrocarbons, including the oils. In other cases, animal matter may have been the source of the hydrocarbons.

Other native asphalts and petroleums were referred to by the author, who concluded by observing, that these products were most probably being continually produced by slow chemical changes in fossiliferous rocks.

ROCK OIL: ITS GEOLOGICAL RELATIONS AND DISTRIBUTION.

On this curious and interesting subject there is a Report of investigations by Professor Andrews, of Marietta College, Ohio, in a paper in *Silliman's Journal*, to which we are indebted for the following. The Professor's investigations, he states, have been directed chiefly to the oil of the coal rocks, and he gives some of his results.

"It is well known," he continues, "to scientific men, that there are in the West two distinct geological formations from which petroleum or rock oil is obtained. These are the bituminous coal measures and the Portage and Chemung groups (the Waverley sandstone of the Ohio reports). The Portage and Chemung rocks sweep around, in the form of a quadrant, from north-western Pennsylvania into Southern Ohio, and south into Kentucky. Upon these rocks the famous oil regions of Pennsylvania and north-eastern Ohio are located. The oil regions of western Virginia and southern Ohio, including a portion of western Pennsylvania, lie in the coal measures. I have assumed that the oil is the product of the distillation of bituminous strata, at low temperatures. This theory, which is a modification of the old one of distillation (at high temperatures), has recently been brought forward by Professor J. S. Newberry, and has received the sanction of many of our most eminent chemists. The chief objection to it is the fact that the coal, cannel and bituminous, in our oil regions, gives no evidence of having lost any of its full and normal quantity of bitumen or hydrocarbons, if judged by the standard of Nova Scotia or English coals. The cannel coal, although somewhat earthy, yields from forty to sixty gallons of oil to the ton.

"The other theory, that the oil was produced at the time of the original bituminization of the vegetable or animal matter, has many difficulties in its way. There is no oil, except in fissures in the rocks overlying the bituminous strata; and these fissures can be shown to have been made since the coal strata became bituminized.

Again, upon this theory, it will be difficult to explain the large quantities of inflammable gas always accompanying the oil.

"That the oil is accumulated in fissures in the rocks, and that these fissures are more or less vertical, there is abundant proof."

Recent advices from America state that the application of the rock oil of Pennsylvania as a substitute for coal and wood for the generating of steam for engine purposes has proved highly successful. The apparatus employed consists of a series of iron pipes, arranged within the fire-box; such pipes being perforated in the upper side with minute holes. The oil is supplied to these pipes by means of a force-pump, so that a continued pressure can be maintained. The space usually filled with fuel is thus filled with a spray of oil, which, once ignited, fills the fire-arch and flues with flame, by which the boiler is heated. The Canadians naturally attach much importance to this invention; the want of coal having hitherto been their great drawback.—*Builder*.

A Correspondent of *Chambers's Journal* says, confidently, that the oil is a product, not of coal, but of coral:—"Stored away in cells," he remarks, "forming, in the aggregate, immense reefs, as it was collected from the impure waters of the early oceans by minute coral polyps, it has been driven by heat and pressure into reservoirs and crevices, where man's ingenuity is discovering it day by day. I have in my possession," he adds, "many specimens of this fossil coral, with the oil plainly visible in the cells."

NATURAL GAS.

MR. BOWDITCH, of Wakefield, in a letter to the *Times*, communicates the following:—At Featherstone, about three and a half miles from Pontefract, and five and a half miles from Wakefield, boring for coal has been in progress for some time, and had reached a depth of 140 yards from the surface. At this depth the boring was advancing through a thick layer of blue sandstone, which overlies the coal-bearing strata throughout a wide area in this district. On April 13, while the borers were at work, a strong smell of gas was perceived, and suddenly an eruption took place, which threw the muddy water from the bore-hole about thirty feet into the air. This continued, and put an end to the boring. Subsequently, some one applied a light to the gas, which then formed a fiery pillar of considerable height, such as would be formed by igniting the gas that would issue from a broken street main through a hole in the soil above it containing water. The gas at Featherstone continued burning, but with a gradually diminishing flame. The flame can be put out by beating the surface of the water with a plank, and it can be relighted at pleasure. The truth, of course, is simple. The iron tools used for boring make a hole in the earth a little larger in diameter than a man's arm, and this hole becomes filled with water from the various strata pierced by the borer. In the blue sandstone above-mentioned there was stored a quantity of gas produced from the coal beneath, and, owing to the close nature of the superincumbent mass,

that gas existed under great pressure. The borer's tool penetrated this stony reservoir of gas, and instantly it forced its way up the bore-hole, and carried onward part of the water which obstructed its exit. The gradual action of the bubbling water has removed some of the surface soil, and hence the visitor sees a hole full of water about ten feet across, part of which is in violent ebullition, owing to the escape of gas, which burns with a flashing and variable flame. The point of scientific interest in the case is the universal testimony that the gas, upon its first eruption, gave as much light as coal gas, whereas the ordinary fire-damp of coal mines is not an illuminating substance. The same thing was seen a few years ago near Aberford, on the estate of Mr. Gascoigne, and also about half a century ago at the Bowling Ironworks, near Bradford. There are also the old cases of a well near Wigan, which took fire on the approach of a lighted candle (*Philosophical Transactions*, 1667), and a ditch in the same locality, of which "the water would seemingly burn like brandy," mentioned in the *Philosophical Transactions* for 1739, both of which resemble the one now to be seen near Featherstone, and both, like it, produced by gas generated in subjacent coal.

HOT SPRINGS OF LANGARNESS.

In a paper on the flora of Iceland, by Dr. Lauder Lindsay, among many other interesting matters relating to this country, now much spoken of as a desirable bourn for vacation tourists, will be found an account of these remarkable Hot Springs. They occur in an "oasis in the desert" of the Reykjavik district. Dr. Lindsay considered the temperature of the water to be about 180° Fahrenheit. He could not retain his hand in it for an instant. Eggs, fowl, and fish could be readily cooked in it; and it was employed by the women for washing clothes and culinary purposes. Luxuriant vegetation characterized the immediate vicinity of the springs, caused by the increased temperature of the soil and the constant abundance of warm moisture in the air. Although this does not correspond with the vegetation in the neighbourhood of the Geysers, yet Dr. Lindsay states that it coincides with the description of the hot springs of India by Dr. J. Hooker, and represents generally the position of hot springs in every quarter of the globe. The paper concludes with a revised and corrected list of the plants of Iceland known up to 1860.

IS WATER COLOURLESS?

Water is usually considered to be colourless; the blue or green colour noticed when it is in large masses being attributed to impurities. From some experiments of Dr. Tyndall, which were recently exhibited at the Royal Institution by Dr. Frankland, it has been proved that Water is not so Colourless as might be supposed. A tin tube, fifteen inches long and three inches in diameter, was placed

horizontally on a stand, and half-filled with water. The tube was closed by plate-glass at each end, and a beam of electric light thrown through it. By this means an image of the contents of the tube was projected on a white screen. That portion of the tube which was filled with air allowed the light to pass through unchanged in colour, when they formed a white semicircle on the screen; but the rays which passed through the stratum of water were seen to have had a greenish blue colour communicated to them. The colour was found to vary from a pure green up to a blue, according to the purity of the water. It is thus evident that the colour of water is very appreciable; for, in a thickness of only fifteen feet, it exhibits a very considerable amount. There is, therefore, no difficulty in comprehending the fact that, in looking through a deeper stratum, such as we see in the Swiss lakes, and in the waters which we have around our own shores, this colour of water is in reality very considerable.

GREAT ERUPTION OF VESUVIUS.

THE *Athenæum* Correspondent writing at Naples, Dec. 17, describes a terrific Eruption of Vesuvius, which he had just witnessed:—

At the commencement, we could see the mighty mass from the roots, which were fixed in the base of the mountain, growing up with wonderful rapidity to a gigantic tree which touched the very heavens, and then spread its branches south and east and west, until the coast, sea, everything was hidden from view. I never witnessed anything grander than the vast masses of smoke which rolled over one another in magnificent involutions, nor anything which gave me a deeper consciousness of the powers of nature than the loud artillery which preceded every impetus of the mountain, shaking our windows and doors at the distance of many miles, and even at sea, as sailors told me, making their boats tremble in the water. As night set in, the spectacle changed its aspect; it was a confusion of black and deep-red colour, only at intervals it being possible to see distinctly the column of fire and smoke. Forked lightning played about the mountain, and formed a scene which no pen can describe. Great numbers of people went over from Naples on the same night. "By ten o'clock on Sunday night (Dec. 12)," said one of the chief authorities of the district to me, "five thousand persons had arrived at Torre dell' Annunziata; others fled to Naples, and some pushed further on to Castellamare,"—and so the flight continued throughout the hours of darkness; and all this anxious time we could hear, at intervals, rounds, as it were of artillery, which shook our very houses. About two o'clock after midnight, the grand crater which has been so long comparatively dormant, opened its fires, giving hopes to the despairing population that their dwellings might yet be saved; but by what infatuation is it, that people still cling to a locality which, within the historic period, has been destroyed nine times? On Monday morning, I went over to examine on the spot the devastation which had been committed. We found Torre del Greco, a thriving place of 22,000 inhabitants, desolate. There were crevices opened in the streets sufficient to interrupt the passage of carriages in some places, and showing the fearful struggles which the imprisoned giant had been making to get out. Houses were riven from top to bottom and opened across the roofs,—few appeared to be habitable in their present state, and one gentleman, unable to effect an entrance by the door of his house, was breaking in the windows. Altogether, the number of houses, up to that time, which had suffered elisions, according to the official statement, amounted to from 400 to 500; but my opinion is that scarcely a house is secure. The road ascends through the city to the mountain, and after walking about a quarter of a mile from the outskirts you arrive at the stream of lava, which at this point is about 28 palms high and nearly half a mile across. It had risen to the roofs of several houses, and was slowly proceeding onwards, though its course had slackened much since

the morning, in consequence of the opening of the principal crater. About half a mile further on, the fiery mouths were visible vomiting forth fire, and smoke, and pumice-stone; but so intense was the heat, and so thick the cloud of fine dust that fell around, that it was painful, if not dangerous, to advance. To count the number of mouths would be difficult, for new ones were opening continually, and it was just as likely as not that we ourselves might have been let in.

The air was tolerably clear in Castellamare; but on approaching Vico we got beneath the column of smoke which the north wind was driving over the Bay, and all the country appeared to be clothed in deep mourning. Black fine dust had fallen everywhere and covered everything. The roads were covered several inches deep; on the houses in Torre del Greco it was ascertained by measure to be 4¼ inches in depth. The details were the same returning as coming, though the prospect was different. The mighty column of smoke we might have imagined had supported the very heavens, except that when it attained a vast height it turned south and spread over the sea, covering the entire Bay, and reaching how far we cannot yet say, though we know that Capri and Salerno were covered with the dust,

On Sunday night the column from the lower mouth, just above Torre del Greco, was calculated to have risen 10,000 feet in height, whilst that from the upper crater was estimated at 3000, and by some at 5000 feet.

Towards the evening the artillery which had been thundering all the day ceased, and nothing remained to excite our wonder but the grand electric lights which played around the crater on the summit, columns of fire and smoke continually rose up, intermingled with forked lightning and globes of pure electric light. During the night and the next morning there were fresh shocks of earthquake, which added to the work of devastation. As Tuesday broke, the sun to us in Naples was eclipsed by the black cloud which still rolled between us and the mountain; but as the orb of day gained a greater height the brilliant effects which were produced on the edges of the column were wonderfully grand. On Wednesday morning the column was much reduced,—the smoke from the lower mouths crept like mist over the surface of the land; two or three sharp shocks of earthquake were, however, felt in Torre, and several houses fell in.

It was obvious to me that the ground around Torre del Greco is hollow, for through the gaps which had been formed in the riven lava, it appeared as if the site on which Torre stood was a thin crust in the form of a vault.

In examining the devastation on the shore, the writer says: "These mighty rocks are of the lava of 1794, and the earthquake has now riven them. The flint-like substances had been cleft as with a knife, and through the middle of them were gushing down streams of imprisoned water set free. The sea had retired twenty palms, from the elevation of the ground, and a little way out it was boiling violently—I believe from the effect of subterranean streams gushing up through the openings which had been made."

Just as the Correspondent was concluding his letter, the mountain burst forth again in brilliant eruption.—See the Letter, in the *Athenæum*, No. 1783.

Vesuvius has altered its shape, ten new craters having been thrown out, while the old one has been deepened.

The *Times'* Correspondent writes, January 4, 5:—

I have visited Torre del Greco again this week, and though Vesuvius has not made any great demonstration during the last few days, the escape of gas increases both at Torre and at Resina. In the streets of the former place the exhalations were so strong as to be almost insufferable, and on approaching the sea they became still worse. A shock of an earthquake on Sunday night drove all the people who have returned out of their houses, and opened a new mouth under the sea, which was boiling most violently for a great distance out. On putting my hand into one place I found the temperature of the water was 33 degrees of Centigrade, and the gas was so strong as to deprive me of breath and almost of my senses for a short time. On land the gas is composed principally

of carbonic acid gas intermixed with a small quantity of carburetted hydrogen, while at sea the proportions are reversed.

VOLCANO ON THE AFRICAN COAST OF THE RED SEA.

CAPTAIN L. R. PLAYFAIR, R.N., states:—At Edd, lat. 13° 57′ N., long. 41° 4′ E., about half-way between Massouah and the Straits of Bab-el-Mandel, earthquake-shocks occurred on the night of the 7th of May or the morning of the 8th, during about an hour. At sunrise, fine dust fell, at first white, afterwards red; the day was pitch-dark, and the dust was nearly knee-deep. On the 9th, the fall of dust abated; and at night fire and smoke were seen issuing from Jebel Dubbeh, a mountain about a day's journey inland; and sounds like the firing of cannon were heard. At Perim these sounds were heard at about 2 A.M. on the 8th, and at long intervals up to the 10th or 11th. The dust was also met with at sea; and along the entire coast of Yemen the dust fell for several days. Several shocks were felt on the 8th at Mokha and Hodaida. —*Proc. Geological Society.*

EVOLUTION OF AMMONIA FROM VOLCANOES.

DR. DAUBENY has read to the British Association a paper in which he remarked: "This phenomenon has been ascribed by Bishop to the decomposition of bituminous matters by volcanic heat; by Bunsen to the lava flowing over herbage, and disengaging its nitrogen, which exhibited itself in the form of ammonia; by the author of this paper, on former occasions, to the direct union of hydrogen and nitrogen in the interior of the earth under an enormous pressure. Now, however, that Wöhler has shown the affinity which subsists between nitrogen and certain of the metals and simple combustibles, some of which, as titanium or boron, combine with it directly with such avidity that the union is attended with combustion; and has also proved that the nitrides formed are decomposed by the hydrated alkalies, ammonia being thereby generated—it had occurred to the author that a more probable explanation of the occurrence of ammonia in volcanoes might be afforded by supposing such combinations to take place in the interior of the earth, and to be subsequently decomposed by the alkalies which are usually present wherever volcanic action is taking place. In confirmation of this view, he appealed to a late observation made by Signor Guiscardi, a distinguished naturalist at Naples — namely, that metallic titanium had been found evolved from the crater of Vesuvius during a late eruption.

GREAT EARTHQUAKE IN SOUTH AMERICA.

THE first intelligence of this fearful catastrophe, in Mendoza, Argentine Confederation, on the 20th of March, was scarcely cre-

dited. It was imagined that the statement in the telegrams, that 7000 persons had perished in the town of Mendoza, was an exaggeration; but subsequent accounts showed that the extent of the calamity at that point had not been overstated. It would appear that this earthquake was inferior in violence to none recorded in history. The private letters state that "the city of Mendoza is no more;" and the number of persons who have perished there is variously computed at from 6000 to 7000. The loss of life was probably rendered the greater by the circumstance that the earthquake was preceded by a remarkable storm and by a hot rain, which drove the inhabitants into their dwellings for shelter. The greater part of San Juan has been destroyed, and 3000 persons are reported to have been killed. San Juan is situated 120 leagues to the north of Mendoza, at the foot of the Andes. The shock was felt with such severity at Cordova, 150 leagues from Mendoza, that the church was thrown down. It was also felt on the same day (March 20) and hour, but without any serious effects, at Buenos Ayres.

Mr. C. Murray, in a communication to the Geological Society, thus enumerates the localities visited by the earthquake:—

At about ¾ to 9 o'clock the first shock, preceded by a thunder-clap, destroyed the city of Mendoza, killing (it is said) two-thirds of its 16,000 inhabitants. Altogether there were eighty-five shocks in ten days. The land-wave appears to have come from the south-east. Several towns S.E. of Buenos Ayres felt slight shocks. No earthquake took place in Chile; but travellers crossing the Upsallata Pass of the Cordilleras met with a shower of ashes; the pass was obstructed by broken rocks, and chasms opened on all sides. At Buenos Ayres, 323 leagues from Mendoza, and elsewhere, it was observed in watchmakers' shops that the pendulums moving N. and S. were accelerated; those moving E. and W. were not affected.

NOTES ON EARTHQUAKES AND EXTRAORDINARY AGITATIONS OF THE SEA.

Mr. R. Edmonds has read to the Royal Institution of Cornwall the following Notes:—

I stated many years since that Extraordinary Agitations of the Sea and of inland lakes are probably produced by vertical Earthquake-shocks acting on the waters perpendicularly to the plane or surface of the ground on which they rest. The effect of such a shock in the bed of a canal would be not only to drive the water from its sides towards the centre, where it would rise into a long ridge, but also to drive the water from its higher towards its lower end. In this latter case the water, when its momentum ceased, would flow back to the higher end, where, rising probably to a higher level than it had before, it would dam back any stream gently entering there. All this was exemplified in the Surrey Canal on the day of the great earthquake of Lisbon. That canal was seven hundred feet long and fifty-eight broad. "The water at its higher end usually deepens from two to four feet, growing gradually deeper to the west end, *where it deepens to about ten feet.*" At and near the higher *(eastern) end* the ridge of water raised in the centre was about ninety

feet long, and between two and three feet above the usual level. This ridge heeled northward, and flowed over the walk on the north side of the canal; on the waters returning into the canal, another such ridge was raised in the middle which heeled southward, and flowed over the walk on the south side. During this second oscillation, the small stream at the higher end, which constantly flowed through the canal, was driven back thirty-six feet towards its source. This was considered* as *the effect of the second oscillation;* but *no oscillation from side to side* could have increased the depth at the higher end where the stream entered. It was probably the *second oscillation from end to end* that dammed back the stream, for *it* must then have reached the higher end of the canal, and deepened the water there. The *oscillations from end to end* no doubt escaped observation on account of the tenfold more striking oscillations *from side to side.*

Every extraordinary agitation of the sea (unaccompanied with a known earthquake-shock) that I have read of, where the state of the weather is mentioned, has occurred during a thunder-storm, or at or near a minimum, of the barometer; whereas earthquakes appear to take place equally in all states of the atmosphere. It is therefore important to ascertain why such earthquakes as are known only by the extraordinary agitation of the sea which they produce should occur exclusively during storms, or at or near minima of the barometer. Is it because submarine shocks are always vertical, while those on dry land are generally horizontal? In *vertical* shocks there may be electrical discharges between the earth and the atmosphere which might occasion the attendant minima, as in the case observed by Humboldt, where "the mercury was *precisely* at its *minimum* height at the moment of the third and last shock," whilst in *horizontal* shocks the discharges may be only between differently charged portions of the earth without much affecting the atmosphere.

Mr. Mallet, in his first report on earthquakes, asks whether the reason why ducks in ponds often rush suddenly from the water immediately before an earthquake may not be, "that with their heads immersed they are able to hear the first distant mutterings while yet inaudible through the air?" But how can this be when sounds do not travel through the earth faster than shocks? It is true that earthquake sounds are often heard immediately before shocks are felt: but such sounds must have been produced, not by the vibrations which were afterwards felt, but by preceding vibrations which were not felt at all. The numberless rapid vibrations constituting a shock vary considerably in power, so that the weaker ones if they came first and reached no higher than the bottom of the pond, might have alarmed the birds before the stronger ones were felt on its banks. That shocks may reach ponds without being perceived by persons close by them was abundantly proved during the great earthquake of Lisbon.

Humboldt, at Cumana, felt an earthquake during a thunder-storm at the moment of the strongest electrical explosion; on the following

* *Philosophical Transactions*, vol. xlix. p. 354.

day at the same hour was a violent gust of wind with thunder, but no shock ; the wind and storm returned for five or six days at the same hour, almost at the same minute: and he states that such diurnal periodicities have been often observed at Cumana, and by M. Arago and himself at Paris. I have observed periodicities equally striking, although the intervals, instead of being days, are lunations (29½ days each) or multiples of a lunation, and generally at the moon's first quarter. As these, as well as those observed by Humboldt, resulted probably from changes in the magnetic or electric state of the earth or atmosphere, which is periodically varying not only each day, but also according to the positions of the sun and moon in respect of the earth, it seems probable that at the end of each lunation, when the circuit is completed, and the sun, moon, and earth have returned to nearly the same relative positions as they had at the beginning, the magnetic or electric states of the earth and atmosphere, and the weather consequent thereon, would also be nearly the same at the end as at the beginning, subject only to such modifications as other intervening influences would occasion. These intervening influences are no doubt so considerable as to render it difficult to determine whether the examples referred to are merely accidental, or whether they depend in some measure on the relative positions of the sun, moon, and earth, and the locality of the observer. The very numerous examples, however, of lunar periodicities which I have given in the *British Association Report* for 1850 (Séctions), p. 32, cannot, I think, be merely accidental. These are exclusively remarkable maxima of the thermometer. Other tables of remarkable lunar periodicities I have given in the *British Association Report* for 1845 and elsewhere, consisting sometimes of maxima and sometimes of minima, and sometimes of the barometer and sometimes of the thermometer, and it might therefore be objected that the proof of lunar influences would have been more satisfactory had the examples been all maxima or all minima of the same instrument. But it must be borne in mind that the weather being at all times dependent on the ever-changing electric or magnetic state of the atmosphere, must be very different in most respects immediately *after* a discharge (visible or invisible) of its electricity or magnetism from what it was immediately *before;* and a considerable maximum one day might be followed by a considerable minimum the next. Some have concluded that the moon has no sensible influence on the weather, because the means of the observations of the barometer or other instruments on the days of new and full moon, and of the quarters respectively, show no difference between any one of these four days and any other. But this proves nothing, as the change expected rarely occurs at the precise day owing to other influences retarding or accelerating it.

Others deny any such influence of the moon, because it is not apparent in the averages of the readings of each respective day of the new and full moon, and quarter days conjoined with the two days before and the two days after it. But should any remarkable change occur, it could not be detected by such averages, as the

maximum or minimum in the former part of these five days would be often neutralized by an opposite state of the instrument in the latter part.

The only way, therefore, of ascertaining whether the moon's first quarter is or is not most remarkable for excessive meteorological changes, is to refer each excessive or remarkable state of the atmosphere to such of the moon's four quarter-days as may be nearest, and then to compare the results.

THE IMPERIAL CROWN OF ENGLAND.

[As incorrect descriptions have, from time to time, appeared of the Imperial Crown, the following corrected details, by Mr. J. Tennant, Professor of Geology and Mineralogy, King's College, London, will be acceptable to the reader. His account is appended to the reprint of Mr. W. Pole's paper on Diamonds.]

The Imperial State Crown of Her Majesty Queen Victoria was made by Messrs. Rundell and Bridge in the year 1838, with jewels taken from old crowns and others furnished by command of Her Majesty. It consists of diamonds, pearls, rubies, sapphires, and emeralds, set in silver and gold; it has a crimson velvet cap, with ermine border, and is lined with white silk. Its gross weight is 39oz. 5dwts. troy. The lower part of the band, above the ermine border, consists of a row of 129 pearls, and the upper part of the band a row of 112 pearls, between which, in front of the crown, is a large sapphire (partly drilled) purchased for the crown by His Majesty King George IV. At the back is a sapphire of smaller size, and six other sapphires (three on each side), between which are eight emeralds. Above and below the seven sapphires are 14 diamonds, and around the eight emeralds 128 diamonds. Between the emeralds and sapphires are 16 trefoil ornaments, containing 160 diamonds. Above the band are eight sapphires surmounted by eight diamonds, between which are eight festoons consisting of 148 diamonds. In the front of the crown, and in the centre of a diamond Maltese cross, is the famous ruby said to have been given to Edward Prince of Wales, son of Edward III., called the Black Prince, by Don Pedro, King of Castile, after the battle of Najera, near Vittoria, A.D. 1367. This ruby was worn in the helmet of Henry V. at the battle of Agincourt, A.D. 1415. It is pierced quite through after the Eastern custom, the upper part of the piercing being filled up by a small ruby. Around this ruby, to form the cross, are 75 brilliant diamonds. Three other Maltese crosses, forming the two sides and back of the crown, have emerald centres, and contain respectively 132, 124, and 130 brilliant diamonds. Between the four Maltese crosses are four ornaments in the form of the French fleur-de-lis, with four rubies in the centres, and surrounded by rose diamonds, containing respectively 85, 86, 86, and 87 rose diamonds. From the Maltese crosses issue four Imperial arches composed of oak leaves and acorns, the leaves containing 728 rose, table, and brilliant diamonds, 22 pearls forming the acorns, set in cups containing 54 rose diamonds and one table diamond. The total number of diamonds in the arches and acorns is 108 brilliants, 116 table, and 559 rose diamonds. From the upper part of the arches are suspended four large pendant pear-shaped pearls, with rose diamond caps, containing 12 rose diamonds, and stems containing 24 very small rose diamonds. Above the arch stands the mound, containing in the lower hemisphere 304 brilliants, and in the upper 244 brilliants: the zone and arc being composed of 33 rose diamonds. The cross on the summit has a rose-cut sapphire in the centre, surrounded by four large brilliants, and 108 smaller brilliants. Summary of jewels comprised in the crown:—1 large ruby irregularly polished, 1 large broad-spread sapphire, 16 sapphires, 11 emeralds, 4 rubies, 1363 brilliant diamonds, 1273 rose diamonds, 147 table diamonds, 4 drop-shaped pearls, 273 pearls.

Astronomical and Meteorological Phenomena.

REPORT OF THE ASTRONOMER-ROYAL FOR 1860—61.

THE Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greenwich, exhibits generally the state of the Observatory on May 10, 1861, and the proceedings in the Observatory from May 20, 1860, to that date. The Astronomer-Royal expects that in a short time a considerable extension of the buildings of the Observatory will be found necessary. It is supposed that there will be difficulty in finding the requisite space on the Observatory Hill, and there are very strong objections against the abandonment of the present site. On May 7, the Observatory obtained possession of Dr. Bradley's observations, which had been carried off after his decease, and found their way into the University of Oxford in 1776; thus preventing access, at the most critical epoch in the history of astronomy, to the only observations on which reliance could be placed, and retarding the progress of accurate astronomy by nearly forty years. It is gratifying to learn that this great gap in the manuscript observations of the Observatory is at length filled up. The astronomical instruments are reported to be in good condition. The external galvanic communications with the telegraphic stations at London-bridge, and with the Admiralty wires, and the Magnetic and Submarine Company's wires at Deptford, are reported to be in the best possible order. The fundamental meridional observations are still considered as their peculiar and sacred charge. The stars observed are principally the following:—192 clock stars; stars generally to the 5th magnitude; new circumpolar stars; moon conculminating stars; stars supposed to have a large proper motion, and variable stars; stars near Sirius; low stars for refraction; stars observed with Mars at opposition; and stars used in defining the Oregon boundary. The moveable bodies observed on the meridian are:—The moon at every opportunity; the sun and inferior planets on every day except Sundays; the superior planets when they pass before 15 h. solar time, and the large ones when they pass with the moon after 15 h. There has been a diminution this year of the number of meridional observations of all objects, and of altazimuthal observations, arising entirely from the excessive badness of the weather in the summer and autumn of 1860, and spring of 1861. Regarding the meteorological and magnetical department, we are informed that all the instruments are in good order. After several trials, a Robinson's anemometer has been established as a part of their permanent apparatus. It has been found much superior to Whewell's anemometer, proving the accuracy of the inventor's theory. Magnetical and meteorological observations, partially reduced, are now sent every day to M. Le

Verrier's *Bulletin*, and in this matter the Telegraph Companies have modified their own office arrangements, and gratuitously given the use of their apparatus and the time of their officers to promote the cause of science.

From the reductions of magnetic observations between 1848 and 1857 (undisturbed days), the Astronomer-Royal has ascertained that there is a great diminution of solar action, amounting to more than one-half in declination. After examining carefully the inequalities of declination and horizontal force, he has been led to the conclusion that the solar diurnal inequality is produced by the radiation of the sun upon the sea, as distinguished from the land; and that the radiation upon the North Atlantic is the principal cause of solar inequality at Greenwich. In regard to lunar inequalities, there appears to be a distinct semi-luno-diurnal magnetic tide in the direction 57° west of astronomical north, or in the direction of Hudson's Bay nearly. The cause of this has not yet been certainly ascertained. The printing of the ordinary observations for 1859 has been long finished. The whole of the results are not printed, but any separate classes of results which individuals may desire are readily furnished in manuscript. The demand for chronometers for the Royal Navy has continued, and in consequence much time has been devoted to the trials and the usual care of navy chronometers. The number in hand has been as high as 220; it is now 120. The Astronomer-Royal has good reason to think that the Observatory is producing a most beneficial effect on the manufacture and adjustment of chronometers in general.

Since open-air galvanic wires have been established, communications with London and Deal have been perfect. The ball at Deal (for which alone the Astronomer-Royal is responsible) is regularly dropped by their current, and the regulation of the Post-office clocks is complete. Time signals are sent daily to almost every part of England. The fitting-out of the steamship *Himalaya*, the conveyance of a party of astronomers and others, natives and foreigners, to Spain, and all the arrangements for the observation of the total solar eclipse of 1860, June 18, has been an additional task upon the Astronomer-Royal. The enterprise, on the whole, was very successful, and much has been gained by the Expedition.

METEOROLOGICAL PHENOMENA AND TERRESTRIAL MAGNETISM.

R. P. SECCHI, the Director of the Observatory at Rome, has addressed to the Paris Academy of Sciences a printed memoir upon the Correspondence or Mutual Dependence of Meteorological Phenomena, and the Variations in the Intensity of Terrestrial Magnetism. From a comparison of magnetic and atmospheric variations, made with great care between February 22, 1859, and November 28, 1860, M. Secchi arrives at the conclusion that there is a real dependence between them. The researches of M. Sabine, on the fluence of the moon, and previous researches regarding the solar fluence upon terrestrial magnetism, do not exclude other causes,

and do not explain the rapid changes in intensity which follow the appearance of clouds in the sky, and rapid variations of temperature. The question thus raised deserves serious attention, not merely on account of its scientific importance, but also because it may be of great practical utility, by enabling us to foretel atmospheric changes. These phenomena are only beginning to be studied by scientific men.

THE GREAT COMET OF 1861.*

On Sunday evening, (June 30,) about ten o'clock, a Comet of extraordinary splendour suddenly appeared. At the same hour it became visible at Rome, Lisbon, Paris, and London. The comet is, in fact, a very small body—the diameter of the nucleus, according to Mr. Hind's measurement, being no more than four hundred miles. Its excessive brilliancy is due to its nearness to the earth. When first seen, it was no more than thirteen millions of miles from this planet—and this evening (Saturday, July 6,) it will be under twenty-three millions from us. The rate at which it is moving from our point of vision is nearly thirty miles a second—more than a hundred thousand miles an hour. So small an object will very soon get beyond our view. French papers say that this is the comet of Charles the Fifth, which has been expected about this period; but this, it appears, is a mistake. Mr. Hind states that "the comet arrived at its least distance from the sun about one o'clock on the morning of June 10, in heliocentric longitude 244° 35′, being then separated from him by 76,000,000 miles. It crossed the plane of the Earth's orbit from the south to the north side in longitude 279° 1′ on June 28, in a path inclined 85° 58′ to the ecliptic. The true orbital motion is direct."

The following communication on the subject is also from the *Athenæum*:—

"Cranford, July 4, 1861.

"Although I watched diligently for a break in the clouds, on Monday, the 1st instant, I did not get a sight of the comet, and it was on the 2nd, at 7 minutes past nine o'clock, that I first perceived the comet. The head of the comet was then as bright as a star of the second magnitude, but appeared to the naked eye fully as large as Jupiter, which was visible near the western horizon; the head was almost vertically over Omicron, in the Great Bear's nose, and during the night retreated almost in the apparent direction of the tail. At about 11 o'clock the tail could be traced for fully ninety degrees; it consisted of a curved brush of light bending over to the direction of the two pointers. The light of this short brush was extremely diffuse on the western side; towards the eastern side a long narrow ray shot out, extended over the zenith, and passed through Draconis, where it again enlarged, and became very faint, but could be traced several degrees beyond an imaginary line, which would join *a* Lyræ and Arcturus. The appearance of the comet in

* From the *Athenæum*, July 6, 1861.

my second Newton's reflector was on the 2nd inst. very like a broken fan, supposing the two lower ribs to be considerably curved, and the height of the fan small in comparison with its width. The nucleus, which was situated at the joint of the ribs, was extremely small and elliptical, the longer axis of the ellipse being in the direction of the length of the tail. Last night the fan-shape of the coma was much more distinct and more generally filled with light; but there were several irregular brighter rays within it. The light of the coma and envelope is much more diffuse and less brilliant than Donati's comet of 1858. I made an attempt on the 2nd to obtain a photograph of the comet in the focus of my reflector; but not the slightest impression was produced by an exposure of two minutes, although a fixed star was clearly depicted. Yesterday, the 3rd, I made several attempts to photograph the comet by means of Rosse's No. 3 portrait lens mounted on the top of my telescope, and carried round by clockwork—not the slightest trace of the comet was depicted in fifteen minutes, although the fixed stars were depicted. As Donati's Comet was photographed by similar means in seven seconds (not by myself), it follows that the present Comet is considerably less actinic than Donati's.

"WARREN DE LA RUE."

We have seen other attempts made to photograph the comet, but without success. The contiguous stars left a strong impression on the prepared glass, but the comet itself left no trace of its presence.

Paris.—M. Le Verrier has addressed the Paris Academy of Sciences as follows, on the Comet:—"We do not know this comet; it is the first time it visits us, and those who have endeavoured to predict its course, determine its distance from the earth, and measure its tail, have either deceived themselves or the public. Three elements are necessary to calculate the orbit of a comet: first, the exact position of the star; then its velocity; and, lastly, the variation of velocity produced by the mass of the sun. I caused the comet to be observed on the 30th of June, and then on the night of the 1st and the morning of the 2nd inst., in order to determine the variation of velocity. These three observations would have followed too closely upon each other for the calculation to be attempted, were it not that the comet moves very rapidly. On the 3rd, at 10 A.M., M. Lévy brought me the result of his calculations, and we then obtained an insight into the orbit of the comet. Mr. Hind has since sent me the orbit calculated by the English astronomers, which perfectly agrees, in all but two minutes, with our results. It is now positive that this is not Charles V.'s comet; and, moreover, it resembles none of those already observed. This circumstance will contribute not a little to throw confusion upon the little we know of these erratic bodies. I cannot yet say whether this comet is periodical or not; its orbit up to this day has been too cursorily determined to enable us to pronounce it elliptical, parabolical, or even hyperbolical. At any rate, appearances are against its return, for *the orbit is nearly* perpendicular to the plane of the ecliptic, while

those of periodical comets usually form a very small angle with that plane. It is only now we can determine the distance of the comet from the earth, and the length of its tail. On the 30th of June the line joining the centre of the sun with that of the comet made an angle of four degrees with that joining the centres of the sun and earth, the length of which is known. The angle which this line formed with the visual ray, drawn from the eye of the observer to the centre of the comet, was 24°. The triangle thus formed may, therefore, be calculated, and it gives us the distance of the comet from the earth, amounting to between 6,000,000 and 7,000,000 of leagues (about 17,000,000 of miles English). The length of the tail might be similarly calculated. The comet is rapidly moving away from us, and it is therefore not surprising that its brilliancy has diminished. On the 10th it will be equally distant from the sun and earth; we shall soon lose sight of it, and astronomers only will be able to follow it for a month longer. It presents a singular peculiarity. M. Chacornac has studied the nucleus with one of M. Foucault's telescopes of a diameter of forty centimètres; instead of its being hollow like the half of an egg-shell, like most of the comets already observed, it presents the appearance of a sun composed of fireworks, the bent rays of which burn in the same sense. Moreover, the comet has not drawn nearer to the sun. These are all circumstances calculated to introduce great complications into the theory of comets."

The Comet as seen at Rome is described by Father Secchi in a communication to the French Academy. The most interesting fact which he relates is that on the 30th of June the polarization of the light of the tail and of the rays near the nucleus was very strong, and could be distinguished by the polariscope in bands, while the nucleus itself presented no traces of polarization, even with Arago's polariscope with a double coloured image. But, however, on July 3, and the following days, until the 7th, the nucleus, in spite of its extreme diminution, exhibited sensible indications of polarization. Father Secchi considers this fact of great importance, since it thereby appears that the nucleus in the first days transmitted its own light, perhaps on account of the incandescence to which it was raised by its near proximity to the sun. M. Poey, the meteorological observer at the Havannah, Cuba, states that he has hundreds of times proved by his experiments that the polarization of luminous bodies in the celestial space is more or less combined with atmospheric polarization, especially so with the polarization of the clouds, except when they are black or stormy. This may combine with the light of a comet by reflection, but it is easy to eliminate it by means of Nicol's prism or a tourmaline.

At Peru (from a local paper, the *Bolsa*):—

On the 9th inst. there appeared within the horizon of this city a beautiful comet, with a nucleus of the size of a star of the second magnitude, a very distinct coma, and a tail about 2 degrees wide, extending diagonally across the heavens over a space of about 30 degrees. By observations taken on the 14th and 16th, it rose the first day at 4 26 a.m., the second at 4 24, the first appearance of the tail taking place 40 minutes previously. On the 14th its position was

in 24 degrees south, *i.e.*, outside the Ecliptic, and close to the Tropic of Capricorn, occupying the constellation "River Eridanus," the tail extending as far as the star of the first magnitude "Achernar." On the 16th it first appeared in 22 degrees, showing that its course is towards perihelion. This comet bears a great resemblance to that of 1680, the return of which was predicted by Newton for 2255, and its position is identical with that occupied by the great comet which was visible in this city in March, 1843.

Arequipa, June 17.

North America (from *Silliman's Journal*).—On Sunday evening, June 30th, between eight and nine o'clock, there was observed at New Haven, in the northern part of the heavens, in an opening between the clouds and at an elevation of about ten degrees, a nebulous body of unusual brilliancy. Its appearance was similar to that of the planet Jupiter shining through a thin mist; and it was nearly as conspicuous an object in the heavens as Jupiter, although this was due not only to the intensity of its light, but partly to its extent of surface, its apparent diameter being about equal to that of the full moon. It was at once suspected that this body was a comet; but this conclusion was adopted with some reserve, on account of the unusual brilliancy and sudden apparition of the meteor. This light was soon concealed by a cloud; but about half an hour later, a larger opening in the clouds disclosed the tail of the comet, in the form of a bright streamer, with sides nearly straight and parallel, and pretty sharply defined. The head of the comet was now invisible; but a little later both head and tail were seen simultaneously, forming together one of the most brilliant comets of the last fifty years, and astonishing every one by the suddenness of its development.

On Monday it was ascertained that on Saturday evening several individuals had noticed in the north a bright streamer, rising to a great height above the horizon, and it was at once concluded that this was the tail of the same comet. The daily newspapers report, that the head of the comet was seen on Saturday evening at Columbus, in Ohio; but it is not known that any one made any accurate determination of its place.

Mr. Bond, the Director at the Observatory of Harvard College, Cambridge, Mass., says, "The suddenness of the apparition of the comet in northern latitudes was one of the most impressive of its characteristics. On the 2nd of July, after the twilight had disappeared, the head, to the naked eye, was much brighter than a star of the first magnitude, if only the effective impression be taken into account, although as to intensity it was far inferior to α Lyræ, or even to α Ursæ Majoris. I should describe the head as nearly equal brightness to that of the great comet of 1858, between the 30th of September and the 5th of October; it should be considered however that the present comet was better situated, from its higher position above the horizon at the end of twilight.

"The aspect of the tail suggested a resemblance to the comet of March, 1843. It was a narrow, straight ray projected to a distance of one hundred and six degrees (106°) from the nucleus, being easily *distinguishable* quite up to the borders of the milky way."

It is obvious from the elements computed by Professor Hubbard, of the U. S. Naval Observatory, Washington, that this comet is not the same as the comet of 1556 (called Charles the Fifth's Comet) whose return has been anticipated for several years; nor do these elements bear any resemblance to those of any comet in the published catalogues. We must conclude, then, that this comet is a new one, whose orbit has never before been computed.

The nucleus admitted of very precise observations; indeed, it is a curious fact, that it would be quite possible, by means of proper comparisons with neighbouring stars, to obtain the differences of terrestrial longitudes of the principal points at which it was observed with a degree of precision only surpassed by the more refined methods known in astronomy.

The near approach of the present comet to the earth, and the sharply defined point of its nucleus, illustrates the practicability of a method of determining the solar parallax with perhaps greater exactness than can be attained by any other means. Many comets have stellar points for their nuclei, visible in the larger telescopes, which admit of as accurate comparisons with neighbouring stars as is practicable in measurements among the stars themselves. Many such have appeared within the last fifteen years. Suppose such a comet to be suitably placed so as to be observed simultaneously in different quarters of the globe, when at a distance from the earth of less than one-twentieth of the sun's distance: under favourable circumstances it would not be hazarding too much to say, that in the course of its apparition the probable error of the solar parallax could be reduced within smaller limits than is possible by means of transits of Venus or of any other method. Such an opportunity might possibly afford an improved value of the mass of the earth.

From the elements computed at the observatory, by Messrs. Safford and Hall, the diameter of the nucleus may be variously estimated at from 150 to 300 or 400 miles. On July 2nd the breadth of the head at the nucleus was 156,000 miles, the height of the inner envelope 11,500 miles, and the length of the tail about 15,000,000 miles.

The reports current of the identity of the comet with those of 1264 and 1556, are without any foundation.

THE DISCOVERY OF A NEW PLANET,

By M. De Gasparis, at Naples, on Feb. 10, was announced at the meeting of the French Academy by M. De Beaumont. It has the brilliancy of a star of the tenth magnitude.

THE PLANETARY SYSTEM.

M. Le Verrier, in a letter to Marshal Vaillant, states the inferences which follow from our present theories regarding the sun, *Mercury*, Venus, the earth, and Mars. M. Le Verrier arrives at the *conclusion* that there are three rings of matter revolving round the

sun; the first, between the sun and Mercury; the second, near the earth, including aerolites, or meteoric stones and shooting stars; and the third, between Mars and Jupiter, consisting of the small planets. His conclusions are as follows:—First. Besides the planets Mercury, Venus, the Earth, and Mars, there exists between the sun and Mercury a ring of asteroids, whose total mass is about equal to the mass of Mercury. Second. At the same distance from the sun as the earth, there exists a second ring of asteroids whose mass exceeds the tenth-part of the mass of the earth. Third. The total mass of the small planets situated between Mars and Jupiter, exceeds one-third of the mass of the earth. Fourth. The masses of these two last groups are complements to each other. Ten times the mass of the group near the earth, also three times the total mass of the small planets between Mars and Jupiter, form a sum equal to the mass of the earth. The last conclusion depends upon the distance between the earth and the sun, as ascertained from the transits of Venus, and the measurement of the distance is generally admitted by astronomers to be very accurate.

ECLIPSE RESULTS.

PROFESSOR FARADAY, in explaining to the Royal Institution Mr. Warren De la Rue's Eclipse Results, has exhibited magnified images of them by aid of the electric lamp, displaying the extraordinary protuberances, clouds, and other appearances which the sun presented in profile when his luminous disc was hidden from sight by the moon. Professor Faraday especially dwelt on the advantages of these photographs in producing images of those rays of light in the luminous phenomena which are invisible to the human eye; and, by way of evidence, had a photograph taken of the coloured rays of the spectrum of the electric light, which showed that the violet and invisible rays have a far more powerful photographic action than the brighter colours. Professor Faraday referred to the varying opinions of philosophers respecting the cause of the luminous prominences, and said that it seemed highly probable that they belonged to the sun itself.

THE RING OF SATURN.

WITH reference to the observation of Mr. Warren De la Rue of peculiarities in the shadow of the Ring of Saturn passing the ball, Mr. Lassell, the Liverpool astronomer, has printed in the *Astronomical Society's Monthly Notices* the following note of the interesting phenomena of an observation made by himself when the ring was in nearly the same position:—"Aug. 3, 1849. The peculiar feature of this unequalled view was that the most minute, but extremely black, shadow of the ring upon the ball, was evidently knotted or notched, conveying the idea of mountains upon the plane of the ring, *intercepting portions* of the thin line of shadow, and almost breaking

it up into a line of dots." Captain W. S. Jacob, of Hartwell, v observed the phenomena on May 19 last, is inclined to attribute th to a variation in the shade or tone of the shadow, by which darker portions appeared to project beyond the rest.

THE MOVEMENTS OF SIRIUS (THE DOG STAR)

HAVE been investigated by M. Calandrelli, director of the P tifical Observatory at Rome, founded and liberally maintained Pius IX., who has purchased for it valuable and expensive ap ratus. M. Calandrelli thinks the anomalies of Sirius are explica by a peculiarity in its movement, without having recourse to hypothesis of a large satellite. M. Le Verrier, after reading above communication, referred to the circumstance of Pius V and Pius IX. having both munificently supported the study astronomy, and added satirically, "This is the way in which Pontifical Government hinders the progress of the natural science

THE WEATHER AND THE SCINTILLATION OF THE STARS.

IN a communication recently made to the Paris Academy Sciences, by M. Liandier, it is stated that the occurrence of sto and similar changes in the Weather may be predicted from twe four to twenty-eight hours beforehand, by observing the Scintilla of the Stars, as shown in a telescope. The image of a star in object-glass is, in fact, a mirror which reflects the condition of atmosphere through which the rays pass. The best indication the state of the upper strata of the atmosphere are said to be tained from a well-defined image of a star of the first magnit when near its point of culmination. At first, there may be se moving apparently in all directions across the image, vibrations waves more or less brilliant, and obscure or coloured. By amining these waves carefully, it will be perceived that they c the disc in one direction, thus showing the direction in wl currents of air are flowing at that moment in the upper region the atmosphere. For instance, when these undulations pass over image of the star from the north-east, they indicate that wi from that quarter are blowing at some distance above the earth, consequently the approach of dry weather; on the contrary, w the waves cross the disc of the star's image from the south-w they foretel rain. The telescope may thus sometimes serve same purpose as a weather-glass.

METEOR IN SOUTH AUSTRALIA.

PROFESSOR NEUMAYER, Director of the Magnetic Observator Melbourne, has, in consequence of a question asked in the Assem *published the* observations made with reference to a Meteor see *March 4, 1861.* The shape of the meteor seems to have been li

cone or wedge, the base being foremost. The light was very intense, resembling that of melting iron. It left behind a train of light resembling the tail of a comet. At one place a sulphuric smell was observed. It was first seen about 9.38 A.M., moving from S. 54° E. to N. 54° W. It first appeared in the south-west when observed in Geelong. Then it seems to have reached the earth in a place some five miles towards the north of Ballarat, and also in a locality some four miles towards the west of Ararat. These facts would lead us to believe that it changed its course after having been deflected by the ground near Mount Hollowback, which place seems to have been marked by a deep furrow of twelve yards. There was no magnetic disturbance at the time. The state of the weather was peculiar, and had been exceedingly oppressive for some days previous. The sky was overcast at the moment of the occurrence, the temperature was 83°, and the wind very slight from the N.N.W. The lowest reading of the barometer since the 19th of February was on the day of the occurrence at 3 P.M., viz. 29·446 inches.

RAIN ON ST. SWITHIN'S DAY.

THE value to be placed upon the popular notion that if it rains upon the 15th of July, it will do so for the 40 succeeding days, may be learnt from the following facts, from the Greenwich observations of the last 20 years. It appears that St. Swithin's Day was wet in 1841, and there were 23 rainy days up to the 24th of August; 1845, 26 rainy days; 1851, 13 rainy days; 1853, 18 rainy days; 1854, 16 rainy days; and in 1856, 14 rainy days. In 1842 and following years, St. Swithin's Day was dry, and the result was—in 1842, 12 rainy days; 1843, 22 rainy days; 1844, 20 rainy days; 1846, 21 rainy days; 1847, 17 rainy days; 1848, 31 rainy days; 1849, 20 rainy days; 1850, 17 rainy days; 1852, 17 rainy days; 1855, 18 rainy days; 1857, 14 rainy days; 1858, 14 rainy days; 1859, 13 rainy days; and in 1860, 29 rainy days. These figures show the superstition to be founded on a fallacy, as the average of 20 years proves rain to have fallen upon the largest number of days when St. Swithin's Day was dry.

THE PRODUCTION OF MIST

Is the subject of a note by the veteran Dr. Davy in the *Edinburgh New Philosophical Journal.* The cause usually assigned for Mist is the access of cold air and its admixture with warmer air, saturated, or nearly saturated, with moisture (such as that resting on the surface of large bodies of water), and strikingly exemplified in our autumnal and winter fogs, when the water, owing to the heat absorbed during summer, is of a higher temperature than the inflowing air. Dr. Davy, however, refers to another cause, not so much noticed—viz., a mild moist air coming in contact with a colder air, equally humid, resting on cold surfaces, whether of land or water, about the end of winter or beginning of spring. He

describes mists which he considers to have been thus formed in the lake district of Cumberland. To a similar cause, also, he refers the phenomenon termed sweating, which is the precipitation of moisture on walls and flagged floors excluded from the influence of fire. He also attributes to a warm south wind succeeding a very cold north wind the deposition of a large quantity of moisture which he once saw on the pictures in the gallery of a nobleman in Devonshire, and quotes the saying in Homer, "The south wind wraps the mountain top in mist."

ENGLISH SUMMERS.

THE highest temperature in the Summer of the year 1861 at any of the 60 stations from which the Registrar-General receives returns was 89°·5, which was reached at Camden Town in August. Last year the highest temperature was 81°, which was attained at Whitehall, and so early as the month of May; in 1859, 94°·4, at the same place in July; in 1858, 97° at Bedford, in June; in 1857, 93° at Worcester, also in June. From watering-places included in these returns of the weather, we learn that 75° was the highest reading this summer at Ventnor, 77°·5 at Fairlight (Hastings), and 81° at Worthing, all in June; while in the north the greatest heat at Scarborough was 73°, and at Llandudno 72°·3, both in August. The mean temperature of the three summer months of June, July, and August at the Royal Observatory, Greenwich, was 61·1° in 1856; 64° in 1857; 62·°5 in 1858; 64°·3 in 1859; 56°·7 in 1860; and 61° in 1861. The average of the last 90 years is 60°. This summer a truly tropical rain fell at Rose-Hill, near Oxford, on the 25th of July, 2·9 inches in about 8 hours.

GROUND-ICE

Is the ice found under the surface of the water in rivers. It has engaged the attention of men of science on account of its apparently unnatural position; and also the attention of practical men because of the mischief it may occasion by accidental obstructions, such as a branch of a tree in a millcourse, when the water is charged with ice particles. Mr. Richard Adie has published a paper in the *Journal of the Chemical Society* on this subject. He believes that he was the first to state that Ground-ice is formed in the coldest part of the stream, and that the small crystals, as soon as formed, are carried along by the current, and submerged and entangled by plants, &c. In Dec. and Jan., 1860-1, he searched for ground-ice where he had previously found it; but, although the frost was severer than it had been for sixty years past, he found it only in one locality—viz., on a stone covered over by the water of a rivulet at Duddington, near Edinburgh. Other observations have led him to the opinion that the position of ground-ice is one of lodgment merely, *in opposition to* the notion that the water has frozen in the bed of *the river, the current* preventing its freezing in its natural place—

the surface. In a note on Mr. Adie's paper, the eminent chemist Dr. E. Frankland, gives his opinion, that the formation of ground-ice, which takes place only in rapidly-flowing streams, depends upon the fact that ice, like other crystalline bodies, deposits itself more readily on rough surfaces (freezes, in fact, at a higher temperature) when in contact with such surfaces, than within the mass of the liquid itself. Hence, when a rippling stream is cooled to 32°, ice crystals attach themselves to the pebbles at the bed of the river, and form nuclei for further deposition.—*Illustrated London News.*

BAROMETERS.

THE following Directions are issued by the Meteorological Department of the Board of Trade :—

A Barometer, for a weather glass, should be placed where it may be seen at any time, in a good light, at the eye level.

It should be set regularly—by a duly authorized person—twice a day.

An explanatory card and a manual should be accessible near the barometer; and should be carefully studied.

In an Aneroid, a metallic, or a wheel barometer, the motion of the hand corresponds to that of mercury in an independent instrument; but such substitutes should be occasionally verified by comparison.

The average height of the barometer in England, at the sea level, is about 29·95 inches; and the average temperature of air in low situations, exposed, but shaded, is nearly 50 degrees.

In order to compare a barometer with others at different places, each should be reduced, by an allowance proportioned to elevation above the sea; and for temperature.

For each hundred feet the barometer is above the mean sea level, add one-tenth of an inch to the observed height; and, for close comparison, when desired, subtract three-hundredths of an inch for each ten degrees which the attached thermometer shows above 32°; or add equally below the freezing-point.

The thermometer is usually about one degree lower for each three hundred feet of its elevation above about fifty feet from the ground.

In general, wind affects barometers more than rain; and temperature is affected by the direction of wind, prevailing or coming, more than by time of day or night, or even by state of sky (while unexposed to radiation)..

LONG TUBE BAROMETER.

MR. R. HOWSON has exhibited to the Institute of Civil Engineers, a Barometer, consisting of a Long Tube freely suspended open end downwards, a cistern which was of a tubular shape, and a "stalk." The stalk was a glass tube, sealed at both ends, attached firmly at its lower end to the bottom of the cistern, and rising axially up the

tube until it nearly reached the surface of the mercurial column. The consequence of this arrangement was, that the top of the stalk came into the region of very low pressure, and there was an excess of pressure tending to force the cistern upwards. This excess was represented by the weight of the cistern (and stalk) and the contained mercury, so that under a given atmospheric pressure the cistern would always hang suspended at a giving level. When the pressure of the atmosphere rose, a portion of mercury left the cistern and passed into the tube, and the cistern also rose, until the level was replaced by the immersion of the glass which formed the tube. When the pressure fell, the converse took place, an elongated scale was thus produced, the extent of range being dependent upon the relative areas of the tube, and of the glass which composed it. The action might also be simply viewed as that of a long piston or plunger, with a liquid packing, having a vacuum on its upper side, and a self-graduating weight attached to its lower side.

RAIN FOLLOWING THE DISCHARGE OF ORDNANCE.

MR. BAXENDALE has made to the Manchester Literary and Philosophical Society, the following communication :—

A paragraph, headed "Rain following the Discharge of Ordnance," appears in a number of the *London Review* for November 16th, 1861. In this paragraph some new facts, drawn from the American war, are adduced by Mr. J. C. Lewis, in support of the view that a violent concussion of the air by the discharge of heavy artillery has a tendency to cause a copious precipitation of rain. Now, if we may be allowed to regard this effect as an established fact, it seems to me to be one of some interest in connexion with the disputed question whether, in thunderstorms, a discharge of lightning is the cause or the consequence of the sudden formation of a heavy shower of rain. Almost every day's experience, in this climate at least, shows that the production of rain is not dependent upon sudden discharges of electricity from the clouds ; and no evidence has ever been brought forward to prove that a high degree of electrical tension in a cloud has a tendency to prevent the resolution of the cloud into rain. Heavy showers often fall from highly electrified clouds without any visible discharge of electricity taking place. We are, therefore, not entitled to assume that the sudden diminution of the electrical tension of a cloud by a lightning discharge can have any material influence upon the rain-forming processes going on in the cloud. As, however, very heavy showers of rain do almost invariably follow lightning discharges, it seems necessary to seek some other cause to account for them. But if we admit that a violent concussion of the air has a tendency to facilitate the conversion of rain-forming material into actual drops of rain, then we may well suppose that the violent concussions produced by lightning discharges, acting on such enormous and dense masses of rain-forming material as are usually collected in heavy thunder clouds, are amply sufficient to produce these sudden and heavy showers of rain.

I am aware that the effect of a discharge of ordnance is usually supposed to be produced by an upward current of air caused by the heat and the gases evolved during the combustion of the gunpowder; but as an hour's sunshine through an opening in the clouds, especially when the sun is at a considerable altitude, would produce a much greater effect in heating and increasing the bulk of the air, this cannot be received as the true explanation of the mode in which the effect of a discharge of heavy artillery is produced.

ON THE FREEZING OF WATER AND THE FORMATION OF HAIL. BY M. L. DUFOUR.

WHEN water is preserved from contact with solid bodies by placing it in a mixture which has the same density, and which does not form aqueous mixtures, its congelation may be materially retarded. Water placed in a mixture of chloroform and oil (the best is oil of sweet almonds) takes the form of perfect globules, and remains at rest in the interior of the mixture. If this mixture be cooled, the water in this condition scarcely ever freezes at 0° C.; its temperature sinks to −6°, −10° before this change takes place. Globules have in this way been even reduced to −20° while still liquid.

The globules either change into globules of ice, or they simply freeze on the surface, according to their dimensions and the diminution of temperature. They persist in the liquid state with remarkable stability. In this mixture of chloroform and oil they may be shaken, and foreign bodies introduced, without solidifying; but solidification immediately ensues when they are touched with a piece of ice. The discharge of a Leyden jar or a galvanic current may traverse these globules without their solidifying; but the powerful discharge of a Ruhmkorff's coil causes their immediate solidification.

When an ice-sphericle formed in the mixture of chloroform and oil is surrounded by other spheres which still remain liquid, the congelation of the latter may be effected by bringing them in contact with the first. Different effects are obtained according to the temperature and dimensions of the globules. Sometimes (with small globules and low tempetatures) the spheres touched solidify suddenly, and remain separate; sometimes (with larger globules and somewhat higher temperatures) they coalesce more or less completely; they stretch out on each other at the moment of solidification. In this way pieces of ice of the most varied shapes may be obtained—irregular spheres formed of concentric layers (each layer consisting of a globule which enveloped the nucleus at the moment of its formation), spheres with protuberances, &c. These varied forms would have but a subordinate interest, if they did not recal the concentric zones and the irregular shapes observed in hailstones. This resemblance is evident in these experiments; and the question naturally arises whether hailstones are not formed under similar circumstances. In a memoir which I shall publish in the *Bibliothèque Universelle*, I examine this analogy more closely, and endeavour to show that it is *not superficial, but* extends into numerous details. I attempt to show

that this particular case of freezing gives a suitable explanation of the general phenomena, as well as of the accidental peculiarities of hailstones: I attempt to show that these aqueous globules may also be cooled below 0° in the atmosphere; that they can then freeze and unite just as in the mixture of chloroform and oil, and that the grains of ice thus formed, increased by the condensation of atmospheric vapour on their surface, may be hailstones.—*Comptes Rendus*, April 15, 1861.

DEATH BY LIGHTNING.

In June last, an inquest was held at Highbury, on the body of Daniel Johns, a carpenter, aged 48. The body presented a most remarkable appearance. The back of the head and neck appeared to have been highly scorched, and in tracing the brown seam of about four inches in width it was found that the electric fluid had passed across the stomach, and thence in parallel lines down the legs to the feet, and so into the earth. The evidence set forth that the deceased was employed with other men in repairing the highway in the Park-road, Tufnell-park, Upper Holloway, and that when the storm came on, between eleven and twelve o'clock on Wednesday, June 5, he took shelter under a hedge, which was overhung by the branches of two trees—beech and willow. He was shortly afterwards joined by Cornelius Tyler, a foreman of navigators, who had an umbrella, under which both men sheltered themselves. They had scarcely done so when a flash of lightning dashed through two opposite houses, striking down the sufferers. A man who shortly arrived on the spot found Johns lying on his back quite dead, with his head on the path and his feet towards the trees, and about two feet from him Tyler was in a sitting posture, but could not move, and was scarcely able to articulate. The cap of each man was torn to pieces and lying on the ground; the umbrella was completely shattered to pieces. The ankle boots, also, which Tyler wore were forced open, the laces being broken into numerous little pieces. Tyler had round his neck a steel watchguard, which formerly was bright, but at that time had the appearance of having been burnt. The shirt also was burnt black under the chain. The jury expressed their opinion that the steel-ribbed umbrella and metallic guard-chain were the conductors of the lightning, which was attracted by the trees, under the shelter of which the men were standing, and finally returned a verdict of "Accidental Death." Tyler rapidly recovered.—*Times*, June 14.

BAROMETER INDICATION FOR NOVEMBER.

Mr. Glaisher, in speaking of the Barometer Indications for November, remarks that at the meeting of the Meteorological Society in that month, Mr. T. Sopwith, F.R.S., referred with confidence to the large number of lives which had been saved on the coast of Northumberland by the caution induced by the

frequent inspection of the barometer which Mr. Glaisher, as the secretary of the Meteorological Society, in conjunction with his Grace the Duke of Northumberland, had placed there the year before. Captain Washington, also, in a letter to the Life Boat Institution, speaks of the attention paid by the fishermen to the barometer on that coast. Fourteen barometers were planted, in the year 1859, on the coast of Northumberland, and nearly 50 subsequently, all made by Messrs. Negretti and Zambra, and examined before use by Mr. Glaisher, at as many other points on the coast of England. At all these places the readings are frequently laid down as a chart, and it is impossible to say how many lives may have been saved by the daily inspection of the zigzag line thus laid down, caused by the varying pressure of the atmosphere in conjunction with the local knowledge of the climate of each locality possessed by every fisherman; inducing caution on the one hand, by the day-by-day falling of the line, and certainty on the other, by the day-by-day rising of the line on the chart. The chart at once speaks to the eye, the past variations up to the time of inspection.

In this way was shown that the pressure of the atmosphere was the least on the 2nd, 3rd, and 14th days, and that until the 16th, with the exception of the 4th, was always below its average, from the 17th to the 20th, 24th, 25th, and the 28th above, and the remaining days below. The average for the month at the level of the sea was 29·74 in., being two-tenths of an inch in defect of the usual average; and when compared with the preceding 20 years, one instance alone of less pressure—viz., in 1852, and one of equal pressure, in 1845, are found. In all other Novembers, 18 in number, the pressure of the atmosphere had been greater than in the past month.

INFLUENCE OF TREES UPON TEMPERATURE.

M. Becquerel has made in the Jardin des Plantes, with the electric thermometer, certain observations at different hours of the day, by comparison of which it was found that about 3 p.m., when the temperature is highest, the difference sometimes amounted to 2° or 3° in favour of the atmosphere above the tree, whilst at sunrise, after a clear night, the excess was on the other side, on account of the nocturnal radiation. This experiment proves the cooling of trees and the atmosphere surrounding them under the influence of nocturnal radiation. Vegetables near a wood are sooner affected by spring frosts and the cold of autumn than vegetables at a distance from them. Under the influence of solar radiation above the trees, there is a current of warm air ascending during the night, and in the morning a current of cold descends to cool the soil. When the sky is cloudy these differences of temperature are very small. These experiments of M. Becquerel also prove the correctness of the conclusions of Humboldt from the observations upon the temperatures observed at 35 stations in North America, extending over 40° in longitude, namely, that the mean annual temperature over *this extent of country has not been sensibly changed by the great destruction of wood which has taken place during the time of the observations.*

METEOROLOGY OF 1861.

Results deduced from the Meteorological Register kept at the Royal Observatory, Greenwich, during the year 1861.

1861. Months.	Mean Reading of Barometer.	Temperature of Air. Highest by Day.	Lowest by Night.	Range in Month.	Mean of all Highest.	Mean of all Lowest.	Mean Daily Range.	Mean for Month.	Departure from average of 20 yrs.	Mean Temp. of the Dew Point.	Mean Tension of Vapour.	Weight of Vapour in a cubic ft. of Air.	Mean additional Weight required for saturation.	Mean Degree of Humidity. Saturation=100.	Mean Weight of a cubic foot of Air.	Relative proportion of Wind. N.	E.	S.	W.	Mean Amount of Cloud. 0 to 10.	Rain. No. of Days it fell.	Amount collected.
	In.	°	°	°	°	°	°	°	°	°	In.	Grs	Gr.		Grs.							In.
Jan.......	30·011	55·0	16·0	39·0	39·6	28·7	10·9	33·9	−4·4	30·1	·168	1·9	0·4	85	564	3	10	9	9	7·0	6	0·6
Feb.......	29·686	56·0	24·4	31·6	48·2	36·9	11·3	42·1	+3·7	39·4	·241	2·8	0·3	90	548	4	4	11	9	7·4	11	1·8
March...	29·614	61·8	29·1	32·7	52·7	37·1	15·6	43·8	+2·1	41·2	·259	2·9	0·3	90	545	4	0	5	22	6·5	21	2·2
April....	29·999	63·5	26·8	36·7	55·0	36·0	19·0	44·3	−2·0	40·2	·249	2·9	0·5	85	551	9	14	2	5	7·1	6	0·8
May......	29·924	80·2	33·4	46·8	63·5	43·0	20·5	51·9	−0·9	43·6	·284	3·2	1·2	74	542	15	8	4	4	7·6	8	1·8
June.....	29·782	81·8	42·9	38·9	70·8	51·3	19·5	59·1	−0·1	53·1	·404	4·6	1·0	81	531	8	8	7	7	7·4	15	1·9
July......	29·606	76·3	48·4	27·9	72·3	53·4	18·9	60·9	−1·0	53·7	·413	4·6	1·3	78	526	1	1	12	17	7·4	20	2·2
Aug.......	29·865	89·3	46·2	43·1	75·6	53·8	21·8	63·2	+1·9	55·2	·436	4·9	1·6	76	528	3	0	10	18	5·9	9	0·6
Sept......	29·717	81·1	37·7	43·4	68·3	48·2	20·1	57·1	+0·2	50·1	·370	4·1	1·2	79	532	2	2	10	16	6·3	15	1·5
Oct.......	29·842	75·6	39·6	36·0	64·1	47·7	16·4	54·9	+4·7	51·4	·379	4·2	0·6	87	536	6	9	11	5	6·5	10	0·9
Nov.......	29·561	57·8	23·2	34·6	47·3	34·1	13·2	40·8	−2·6	37·1	·221	2·6	0·4	87	547	4	1	9	16	6·9	15	5·2
Dec.......	29·974	54·0	23·5	30·5	45·9	36·0	9·9	41·0	+0·9	37·3	·223	2·6	0·4	87	555	5	10	7	9	6·5	10	1·3
Means...	29·798	69·3	32·6	36·7	58·6	42·2	16·4	49·4	+0·2	44·3	·304	3·4	0·7	83	542	5	5	8	11	6·8	146 Sum	20·8 Sum

NOTE.—The sign + implies above, and the sign — below the average.

EXPLANATION.

The cistern of the barometer is about 159 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of Mr. Glaisher's corrections, as published in the *Philosophical Transactions*, Part I., 1848; and from the readings of the dry and wet bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11, 12, 13, 14, 15, and 16, are calculated by means of Mr. Glaisher's Hygrometrical Tables. *Second Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of the column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in col. 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air. [*Concluded on next page.*

The reading of the barometer] was above its average value in January, April, May, August, October, and December; and in defect in the remaining months of the year.

The mean reading of the barometer for the year, at the level of the sea, was 29·978 inches.

The mean temperature of the air was above the average value of 90 years in February, by 3°; March, by 3°; June, by 1°; August, by 2½°; September, by ¾°; October, by 5½°; December, by 2°; and below, in January, by 2¼°; April, by 1½°; May, by ½°; July, by ½°; and November, by 1½°.

The mean high day temperature was above its average value in February, March, August, September, October, and December; and in defect in the remaining months of the year.

The mean low night temperature was above its average value in February, March, June, July, August, October, and December; and in defect in the remaining months of the year.

The temperature of the year 1861 was 0°·2 above the average value of the 20 preceding years.

The highest temperature of the year was 89°·3 in August, and the lowest 16°·0 in January; giving a range of temperature of 73°·3.

The mean weight of a cubic foot of air was 564 grains in January, 531 grains in June, 555 grains in December; and the average for the year was 542 grains, exceeding the average value of the preceding twenty years by 1 grain.

The mean temperature of the air for the year was 49°·4; and that of the dew-point was 44°·4. The mean degree of humidity was 83, complete saturation being represented by 100. Rain fell on 146 days, the amount collected was 20·8 inches.

The rapid thaw which set in on December 30th, 1860, and which was mentioned in the *Year-Book* for 1861, continued only to the 1st of January, 1861; the temperature on this day (January 1st) rose to 47°; it fell by midnight to 32°, and to 28° by the morning of the 2nd; it then rose to 34°, and fell to 25° by midnight. It was as low as 11° on the 9th day.

From January 2nd the weather was cold, on the 6th, 8th, 9th, and 10th day, the departures below their averages were 12°·4, 11°·0, 10°·4, and 14°·0 respectively, and the average daily deficiency to the 23rd day was 3°·7; a warm period set in on the 24th and continued for the most part till the end of the quarter; the average daily excess for the 67 days ending March 31st was 3°·3.

The mean temperature of the 10th day was 21°·7, being lower than any day during the first half of January since 1835.

The mean temperature of the first half of January was remarkable; its mean value was 28°·3, being smaller in value than in any year for more than 20 years, as will be seen by the following table:—

The mean temperature of the first half of January in—

1841	was	29·2°	1848	was	37·9°	1855	was	41·3°
1842	,,	30·7	1849	,,	36·9	1856	,,	37·3
1843	,,	35·6	1850	,,	34·7	1857	,,	38·2
1844	,,	38·6	1851	,,	44·5	1858	,,	36·5
1845	,,	39·9	1852	,,	41·4	1859	,,	37·6
1846	,,	39·6	1853	,,	45·4	1860	,,	40·9
1847	,,	36·6	1854	,,	34·0	1861	,,	28·3

Going further back, the period was cold in 1838, its value was 29°·5. The next was in 1826, its value was 28°·7; and back to 1814 there are only two cases exceeding in severity the first half of January in this year, viz., in 1814 and 1820; their values were 25°·6 and 24°·9 respectively.

Therefore the cold of the first half of January this year was more rigorous than in any corresponding period since 1820, that is, in 41 years; and was exceeded in severity twice only back to 1814, that is, in 48 years.

From the preceding facts the month of January, 1861, is exceptional, and it is a matter of interest to trace back, with a view of ascertaining the relative frequency of severe Januaries in comparison with those at the beginning of this century.

The following table gives instances of the temperature of the month of January *equal to or less than* that of January in the present year.

The mean temperature of January in the year—

1771 was	29°·9	1795 was	23°·9	1826 was	32°·0
1772 „	32·2	1799 „	33·3	1827 „	33·4
1774 „	31·5	1802 „	32·9	1829 „	31·7
1776 „	27·0	1803 „	33·4	1830 „	30·7
1777 „	33·9	1811 „	32·8	1838 „	28·9
1780 „	28·6	1814 „	26·9	1841 „	33·6
1784 „	29·2	1815 „	31·9	1842 „	32·9
1789 „	33·4	1820 „	31·7	1850 „	33·7
1794 „	33·3	1823 „	31·8	1861 „	33·9

From these numbers it appears that the coldest January was in 1795, the next in order of severity were 1814, 1776, 1780, 1838. Of these remarkably low temperatures for January, eleven occurred in the 30 years ending 1801, and eleven in the next 30 years; but five only in the 30 years ending 1861.

***The range of temperature* in January was large at all places. The extreme readings at different places are shown in the following table:—**

Table of the Maximum and Minimum Temperatures during the month of January, 1861.

Names of Stations.	Highest.	Lowest.	Range.	Names of Stations.	Highest.	Lowest.	Range.
Guernsey	52°·0	25°·0	27°·0	Cardington	53°·0	10°·0	43°·0
Helston	59·0	28·0	31·0	Aspley	49·2	20·5	28·7
Truro	57·0	24·0	33·0	Lampeter	58·0	4·2	53·8
Teignmouth	57·0	13·3	43·7	Bedford	53·0	14·0	39·0
Exeter (St. Leonards)	59·7	9·7	50·0	Llandudno	57·5	22·3	35·2
Exeter (High-street)	55·2	11·9	43·3	Norwich	52·0	4·0	48·0
Osborne	54·5	20·7	33·8	Diss (Norfolk)	51·0	−1·0	52·0
Ventnor	52·0	24·0	28·0	Grantham	53·4	18·9	34·5
Worthing	46·8	22·0	24·8	Belvoir Castle	54·5	15·0	39·5
Fairlight	48·0	19·7	28·3	Derby	54·0	18·0	36·0
Little Bridy	56·3	16·5	39·8	Holkham	53·0	3·3	49·7
St. John's College (Brighton)	53·0	15·0	38·0	Nottingham	56·0	16·5	39·5
Petersfield	52·0	13·0	39·0	Hawarden	57·5	19·0	38·5
Barnstaple	59·0	10·6	48·4	Thelwall near Warrington	54·3	16·2	38·1
Aldershot Camp	53·0	14·0	39·0	Liverpool	55·0	23·9	31·1
Clifton	57·1	9·7	47·4	Manchester	55·0	15·0	40·0
Lewisham	55·0	11·0	44·0	Wakefield	59·3	9·0	50·3
Royal Observatory	55·0	16·0	39·0	Harrowgate	55·0	14·0	41·0
Regent's Park	52·0	13·0	39·0	Leeds	57·0	12·0	45·0
St. John's Wood	53·0	18·5	34·5	Stonyhurst	53·4	12·4	41·0
Guildhall	52·6	21·9	30·7	Kingsley Parsonage	55·5	15·5	40·0
Whitehall	54·5	19·7	34·8	York	55·5	14·5	41·0
Camden Town	52·4	14·3	38·1	Scarborough	50·0	14·0	36·0
Battersea	53·4	15·2	38·2	Ben Rhydding	53·5	10·5	43·0
Leyton (Essex)	51·2	12·9	38·3	Otley	53·8	15·3	38·5
Pembroke Dockyard	54·6	14·8	39·8	Isle of Man	50·5	20·5	30·0
Rose Hill (Oxford)	51·4	17·1	34·3	Bywell	57·0	7·0	50·0
Oxford	52·7	17·0	35·7	Allenheads	49·5	9·9	39·6
Great Berkhampstead	51·0	10·3	40·7	St. Paul's Parsonage	54·0	9·4	44·6
Hartwell House	56·8	16·5	40·3	Carlisle	57·2	10·6	46·6
Hartwell Rectory	51·8	18·0	33·8	North Shields	52·0	9·0	43·0
Royston	54·0	14·4	39·6	High House	57·0	17·0	40·0
Gloucester	55·0	11·0	44·0				

The weather was cold from April 1st till the middle of May, the mean daily temperatures of the air for the 44 days ending May 14th being 3°·0 below the average for this period. On the 15th and 16th of May the days were comparatively warm; the excess of temperature was 5°·5 on the former, and 8°·5 on the latter; these, however, were followed by 3 cold days: the deficiency of temperature on the 17th, 18th, and 19th was 5½° daily. From the 20th of May to the end of June the weather was generally warm; the average daily excess of temperature of the last 42 days was 1°. From July 1st till the 3rd day of August the temperature of the air was generally a little below the average; the mean deficiency for the first 34 days amounted to ¾° daily; a warm period set in on August 4th, and continued till September 11th; the average daily excess of temperature was 2½°, from September 12th to September 27th, the weather for the most part was cold; the average defect daily was 0°·6 only. A warm period set in on September 28th, and continued till the end of October.

The mean temperature of the month of October was 54°·9, being in excess of the average of 90 years by 5°·4, of 43 years by 5°·0, and of the preceding 20 years by 4°·7; and we must travel back to 1831 for so warm an October, and then back to 1811 for a second instance, and examining still further back to 1770 we fail to find a third instance. The mean temperature in 1831 was 55°·0 and in 1811 was 55°·5.

A marked change in the weather took place on November 1st, and the temperature till the 24th day was, with the exception of the 5th and 6th days, always below the average, and at times to 10° and 11°, the 18th day was remarkable, its mean temperature was 27°·1, being no less than 15°·1 below the average temperature for the day, and the temperature of the air was below 32° all the day; there were two days of similar character in November, 1858, on the 23rd and 24th, but with this exception we must go back to 1829 for a day of so low temperature in November. On November 25th another great change took place from low to high temperatures the mean temperature of the 26th day was as high as 53°·1 or 26° higher than on the 18th; this warm period continued to December 24, and the average daily excess was 3¾°; and from Christmas Day to the end of the year was cold, showing a deficiency of temperature to the amount of 3½° daily.

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE OR ART. 1861.

SIR PETER FAIRBARR, Civil Engineer.

GEORGE BISHOP, F.R.S., whose taste leading to Astronomy, he built an observatory in his grounds in the Regent's Park in 1837; and two men well known in the astronomical world were successively placed in charge; Mr. Dawes in 1839, and Mr. Hind in 1844. Of the valuable and sustained labours of both we cannot speak to the world at large: but the discovery of ten planets by Mr. Hind is known to and understood even by those who cannot appreciate the methods employed. Mr. Hind's first pair of planets (Iris and Flora), August 13, and October 18, 1847) were the third and fourth of the sixty-six which have been added in our own day to the four discovered at the beginning of the century. Hencke, an amateur astronomer, had opened the new path by the discovery of Astræa in 1845, and of Hebe in 1847 (July 1): so that Mr. Bishop's observatory was especially directed to the new path of discovery at the first hint of the path being open. Mr. Bishop was successively Secretary, Treasurer, and President of the Astronomical Society, in the management of which he took part for twenty-five years.—*Athenæum.*

FRANCIS DANBY, A.R.A., a painter of genius.

DR. JOHN WILLIAM DONALDSON, author of *The New Cratylus.*

MACGREGOR LAIRD, the African explorer, author of the *Narrative of an Expedition up the River Niger.*

LEIGH SOTHEBY, remarkable for his antiquarian knowledge of Printing.

B. **Woodward**, the architect, known as the partner of Sir Thomas Deane, and in connexion with the Dublin and Oxford New Museums.

Thomas W. Atkinson, architect, and traveller in Oriental Russia. By pen and pencil Atkinson opened to Western Europe, and even to the Russians of St. Petersburg and Moscow, the vast regions of the Amoor.

William Wilson, C.E. The deceased was born in 1768: by self-culture he became familiar with many branches of science, ere he had reached manhood. He became a member of the London Mathematical Society (established in 1719), and was elected president, discharging the duties of that office for more than forty years. For a long series of years he was analytical chemist at Guy's Hospital; and, during his engineering pursuits, he was the projector of the canal tunnel at Islington, the East London Water Works at Old Ford, and several other important undertakings. For twenty years he was chief engineer of the Gas Works at Haggerstone; and it may be mentioned, to the credit of the directors of that company, that, on his retirement from the active pursuits of life, they settled on him a handsome annuity, which he enjoyed up to the period of his demise, at the advanced age of 93 years.—*Abridged from the Builder.*

Sir Francis Palgrave (whose proper name was Cohen, which he changed to Palgrave on his conversion from Judaism and his appointment to office). He was a good scholar and a clever writer. His works are numerous and voluminous; but his fame will mainly rest upon his contributions to early English History.—*Athenæum.*

Sir William Cubitt, F.R.S., the distinguished engineer. When young, he was remarkable for his knowledge of mechanical engineering, in which branch he introduced some ingenious improvements. At an early age, he was extensively engaged in the construction of gas-works, and self-regulating sails for windmills; and in 1825, he invented "the treadmill." Among his principal Civil Engineering works may be mentioned the South-Eastern and the Great Northern Railways; the gigantic floating landing stages at Liverpool; the iron bridge at Rochester; and the effective superintendence of the construction of the Crystal Palace in Hyde Park in 1851, which service was recognised by Her Majesty conferring on him the honour of knighthood. Sir William Cubitt's success was doubtless, in a great degree, to be ascribed to the soundness of his early mechanical experience.

Reitschell, the sculptor, at Dresden, who died on the eve of the day when he was to have exhibited his last work—a car with four horses, destined for Brunswick, and the models for the statues of Luther and of Wickliffe, for the monument of the Reformation at Worms.

Robert Burford, the clever painter of Paronamas, exhibited in Leicester-square: the secret of his success lay in the perfection of his perspective. A minute account of the Panoramas of Mr. Burford and his father, and the Barkers, father and son, will be found in the *Curiosities of London.*

Eaton Hodgkinson, Professor of Mechanics and Engineering in University College, London. At Manchester, Mr. Hodgkinson first turned his attention to the subject of the strength of materials, in the experiments carried on at the expense of Mr. Fairbairn, whose own investigations he greatly assisted; and also by means of grants from the British Association for the Advancement of Science. The data for the construction of the Britannia Tubular Bridge were provided to Mr. Stephenson by Mr. Hodgkinson, to whom Mr. Fairbairn referred him. Mr. Hodgkinson edited *Tredgold on the Strength of Cast-Iron and other Metals*, and its supplementary volume. He was a Fellow of the Royal Society, and an honorary member of the Royal Institute of British Architects, and of the Institution of Civil Engineers.

Professor Hosking, architect, and writer of the articles "Architecture and Building," in the 7th edition of the *Encyclopædia Britannica;* treatises which gave him at once a reputation. In 1834 Mr. Hosking became engineer of the Birmingham, Bristol, and Thames Junction Railway, now known as the West London Railway; and designed for it the arrangement near Kensal-green, by which the Paddington Canal is carried over the railway, and a public road over the canal. In 1840 he was appointed Professor, at King's College, London, of the "Art of Construction;" and afterwards of the "Principles and Practice of Architecture," which he held until his decease. Amongst his published works should be mentioned an Essay on

the Construction of Bridges, for Mr. Weale; *A Guide to the Proper Regulation of Buildings in Towns*, 1848; and a thin folio setting forth his claim to be considered the originator of the scheme adopted to increase the accommodation of the British Museum—the circular structure in the quadrangle.

J. M. Derick, architect of the church at Leeds designed for the Hon. and Rev. E. B. Pusey.

Dr. Southwood Smith, an early advocate of Sanitary Reform.

John Thomas Quekett, whose superior attainments as an anatomist, especially in minute dissections and microscopical investigations, obtained him a permanent appointment in the Hunterian Museum. He was there principally occupied in extending and arranging the series of microscopical preparations; and the work on which his great reputation as a Histologist is chiefly based is the *Illustrated Catalogue* of the specimens, showing the minute structure of tissues, in the College Museum in Lincoln's Inn Fields. Mr. Quekett was appointed Professor of Histology; and on the retirement of Professor Owen in 1856, became principal Conservator of that museum. Professor Quekett's published works on the Microscope and Microscopical Anatomy have a high and deserved reputation; his great experience and vast extent of information made his opinion of peculiar value, and in much request on obscure diseases and morbid alterations of structure; and the uniform readiness and urbanity with which he imparted his knowledge to all who visited for that purpose the Museum of the Surgeons' College, will make the memory of this most worthy and valuable officer gratefully cherished. Physiological science and the medical profession have sustained a great loss in this excellent and, whilst health and strength were spared him, indefatigable man. Professor Quekett was selected by the Council of the Royal Society from the candidates for Fellowship, and was elected in 1860.—*Athenæum.*

John Francis, sculptor, well known by his portrait busts.

Alexander Gilchrist, author of a *Life of Etty*, written in a very different spirit from that which has produced the recent artistic biographies of Hogarth and Turner. Mr. Gilchrist was known as an Art-critic of great experience. It was but the other day we announced the early publication by him of a *Life of William Blake*, the painter of mysteries, to be illustrated by numerous engravings and fac-similes from his extraordinary designs.—*Athenæum.*

Herr Zveiner, architect, engaged on the restoration of Cologne Cathedral.

Richard Grainger, well known as the architect and builder to whom Newcastle-upon-Tyne is indebted for almost all its modern improvements and decorative character. The beginning of his life was in the most obscure circumstances. By his intelligence and activity he rose from a carpenter's apprentice to be able to achieve the results above referred to, and the realization of a large fortune for himself.

Sir John Forbes, M.D., physician to Her Majesty's Household. In 1821, he introduced to the English practitioners the great discovery of auscultation by translating Laennec's treatise, and wrote an original work on the same subject in 1824. Sir John was an honorary member of the principal medical societies of Europe and America, one of the editors of the *Cyclopædia of Practical Medicine*, and the author of several professional and other works. He was a man of truly benevolent nature.

Professor Wilhelm Hensel, painter to the Court, and brother-in-law to the late Felix Mendelssohn-Bartholdy.

Thomas Finden, architect, who some time practised in conjunction with Mr. T. Hayter Lewis; he was the brother of William and Edwin Finden, the well-known engravers.

Johan David Passavant, the well-known German Art-historian.

Joseph Maudslay, C.E., of the firm of Maudslay, Sons, and Field, Lambeth. Mr. Maudslay (says the *Mechanics' Magazine*) was among the first to perceive the advantages of direct-acting engines for marine purposes, and in 1827 patented an arrangement for applying the ordinary slide-valve, worked by an eccentric, to engines with oscillating cylinders. The prejudice, however, was so strong against the use of oscillating cylinders, that other forms of direct-acting engines were devised; and in 1839, in conjunction with his partner Mr. Field,

he patented the double cylinder arrangement of direct-acting engines, which was very extensively adopted by our own and foreign Governments for vessels of war, and also by the Mercantile Marine. The prejudice just mentioned has since been removed, and oscillating engines are now looked upon by many as the most successful arrangement of direct-acting engines for paddle-wheel propulsion; for very large powers the fixed double-cylinder engines are to be preferred. In 1841, Mr. Maudslay also patented the annular cylinder arrangement, which was successfully used in several of the fast packets between England and France, and in others running to the Channel Islands. Mr. Maudslay also first applied with success the steam-engine to drive the screw direct; now almost universally adopted, not only in the Admiralty service, but also in the Mercantile Marine.

Louis Joseph Vicat, the well-known engineer of the Ponts et Chaussées. At Souillac, Vicat introduced the system of founding the piers of bridges on masses of concrete, sunk under water within close-piled enclosures, or "caisses sans fonds;" and to secure the success of the system it was necessary that he should use a lime which should be capable of setting under water. About 1817, Vicat communicated to the Académie des Sciences the results of his analytical and synthetical experiments upon the composition of limes of various qualities; and he then propounded the theory which subsequent inquiries have confirmed and developed, to the effect that the hardening of mortars depended on the combination which takes place in them between the lime and the silicate of alumina they contained. Vicat published in some separate *brochures* the results of his subsequent experiments; and in the *Annales des Ponts et Chaussées* he has also published some important Mémoires on the strains to which suspension bridges are exposed, on the resistance of iron-wire ropes, on the compression of solid bodies, and on the statistics of the lime-producing formations of France. He co-operated with M. St. Leger in the introduction of the manufacture of the artificial hydraulic limes; indeed he must be considered to have led the way to all the modern improvements in that important branch of the building arts. M. Vicat received honours from every government which in turn has ruled in France during his long and useful career; and in 1845 the legislature of his country unanimously voted him a pension of 6000 francs a-year, on the strength of a report presented by MM. Arago and Thénard.—*Address of the President of the Institute of British Architects.*

M. Berthier, the distinguished author of the *Traité des Analyses par la Voie sèche*. Berthier devoted, in fact, much attention to the examination of Vicat's discoveries, and has discussed the principles on which they are founded: he also paid attention to the analytical inquiries into the nature of other building materials, and of the metals used in construction.

Henry Austin, C.E.; he was a pupil of Mr. Robert Stephenson, and assisted with the drawings for the (then) London and Birmingham Railway, and the London and Blackwall Railway. He afterwards accompanied the late Lieutenant Waghorn through Italy, at the time the latter was arranging the Overland Route. "Mr. Austin was formerly Secretary to the General Board of Health, and of late years Superintendent and Inspector of the Department charged with the Administration of the Local Management Act. On the commencement of the Sanitary Movement, Mr. Austin seems to have succeeded in securing the attention of its leaders; and he was thus connected with the singular theories of sumpts, of small-pipe drains, and pot-pipe gathering-grounds, which for so many years were forced upon the unfortunate towns who submitted to the guidance of the General Board of Health."—*Address of the President of the Institute of British Architects.*

M. Wertheim, to whom we are indebted for some important investigations in the laws of elasticity, and of the sonorous vibrations of air and gases. In 1846, M. Wertheim published a Mémoire, written in conjunction with M. Chevandier, "upon the mechanical properties of wood," and in a Mémoire "upon the double refraction produced in isotropous bodies," M. Wertheim discussed the results obtained by Mr. Hodgkinson from his experiments upon the elastic conditions of wrought and cast-iron; suggesting, for the purpose of observing the gradual effects of compression of solid bodies, the elegant chromatic dynamometer. See the Mémoire in the Annales de Chimie.

General Sir Charles Pasley, author of various papers in the corps papers of the Royal Engineers; *Observations on Limes, and Calcareous Cements*; and

remembered by his interesting operations for the removal of the wreck the *Royal George*, and in blasting the Round Down Cliff, near Dover: he was also Inspector of Railways.

James Braidwood, nearly thirty years Superintendent of the London Fire Brigade, and who lost his life in the discharge of his duties at the Great Fire in Southwark in 1861.—"None of the famous soldiers or seamen whose names adorn the long annals of our glory, deserved more highly the statues raised in our public places to commemorate their deeds, than does the plain, faithful, courageous Mr. Braidwood, a true Christian hero, killed in the discharge of his duty."—*Mechanics' Magazine.*

General Sir Howard Douglas, military engineer, author of many scientific Treatises, especially on Fortification and Gunnery; and a staunch advocate of the superiority of wood over iron for shipbuilding. He continued to devote himself to the service of artillery and shipbuilding almost to the day of his death, in his 85th year.

Dr. Baly, F.R.S., Physician Extraordinary to the Queen.

Sir William Burnett, M.D., late Director-General of the Medical Department of the Navy.

The Rev. James Cumming, Professor of Chemistry at Cambridge.

John Cross, historical painter.

H. H. Pickersgill, artist.

R. C. Neville, Lord Braybrooke, archæologist.

J. J. Taylor, Civil Engineer.

The Rev. Joseph Hunter, archæologist.

Vincent Novello, musician, and writer on musical science.

Isidore Geoffroy Saint Hilaire, son of the celebrated Etienne Geoffroy St. Hilaire, who died in 1844. The distinguished man just deceased was elected, when only twenty-one years of age, a member of the Academy, of which his father was then the president. He was subsequently appointed Professor of Zoology at the Museum, Director of the Menagerie, Councillor and General Inspector of Public Instruction, and honorary member of the Imperial Academy of Medicine. At the period of his death he held the office of administrative Professor to the Museum of Natural History. To M. St. Hilaire was due the foundation of the Imperial Zoological Society of Acclimatization, of which the presidency was awarded to him in 1854—a post which he retained up to the time of his death.—*Athenæum.*

The Rev. John Stevens Henslow, Professor of Botany in the University of Cambridge, Fellow of the Linnean and Geological Societies. He made botany the chief object of study and prelection, and in the elucidation of the subject he applied his chemical, physiological, and mathematical knowledge with the highest success. He diffused a taste for botanical science among the undergraduates, as well as among other members of the University, not merely by his lectures, but by his excursions into the country. His herborizations were well attended, and much practical information in field-work was conveyed. He contributed botanical papers to the Cambridge Philosophical Society, and wrote the volume on botany in Lardner's *Cyclopædia.* Henslow originated great improvements in the farming of Suffolk; he was one of the founders of the Cambridge Philosophical Society; and of the British Association for the Advancement of Science.—See the Memoir in the *Edinburgh New Philosophical Journal*, No. 27, N.S.

His Royal Highness, Albert, Prince Consort, Chancellor of the University of Cambridge; Vice-President of the Royal Society; President of the Society of Arts, and of the Royal Horticultural Society; Honorary Member of the Institution of Civil Engineers, &c. His Royal Highness was one of the originators of the Great Exhibition of 1851, and the International Exhibition of 1862; and he presided at the Meeting of the British Association at Aberdeen, in 1859. The Addresses of Condolence which have been presented to Her Majesty on the lamented death of this amiable Prince bear testimony to the zeal with which he entered into the pursuits of the cultivators of different branches of science, and how largely the Prince promoted and diffused scientific knowledge, both by precept and example.

Dr. Fyfe, *Professor* of Chemistry at Aberdeen.

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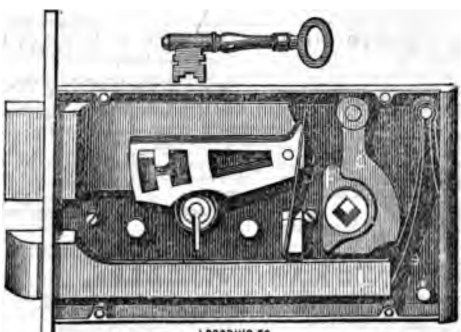

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